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ESTABLISHED 1856. REGISTERED AS A NEWSPAPER.

VOL. CLIX.—No. 4140] 28, ESSEX ST., LONDON, W.C. 2. [MAY 17, 1935

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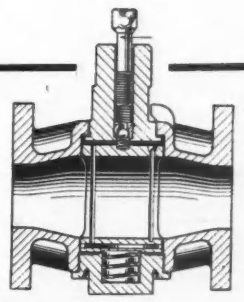

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The British Industries Fair, Engineering and Hardware Section, 1935, will be held in Birmingham from May 20th to 31st inclusive.

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NOTE: All other Sections of the Fair are held in London in February each year.

D.A.64.B.

A Seven-Day Journal

Engineering in Scotland.

WITH the Spring issue of its official journal, the Scottish National Development Council starts a series of special Areas Supplements, the first of which deals with the engineering trades. In the section discussing progress in iron and steel, it is stated that co-ordination of production and centralisation of control have been noteworthy developments in Scotland during the past few years. Steel-making especially has seen a definite unification, while various inter-branch agreements have been arrived at throughout the industry as a whole. In the realm of pig iron, while no amalgamations of outstanding importance have been effected, a much closer basis of working has been reached, especially as regards the buying of ore and similar material. The position of other branches of the industry—shipbuilding, marine engineering, boiler-making, locomotive building, and structural work—is also briefly considered, and the supplement concludes with a survey of the development prospects. The principal point made in this section is the "unique advantages" as a munition centre possessed by the Glasgow district in the distance it is situated from the Continent of Europe. The much-talked-of "drift South" of industry can, it is thought, be overdone. "Convenient geographical location of industry," it is pointed out, "is a factor of the utmost significance for the British Empire, and in the past this question of location has received something less than the attention it deserved. The Committee of Imperial Defence will one day take more than a mild interest in the geographical position of engineering industries." The possibilities of a great development of aerial warfare is, the review continues, a fact which cannot be ignored, and it is therefore of the first importance that a large amount of the engineering industries of this country should be kept as far as possible from the Continent. The district around Glasgow and the West of Scotland, being the only great heavy industrial area in this country which is more than 400 miles from the nearest Continental port, offers, it is maintained, advantages which in this respect are unequalled.

An International Shipping Conference.

IN a Journal note of January 25th, we made reference to a draft scheme dealing with surplus shipping which was drawn up by the Preliminary International Conference on Rationalisation of Shipping, held in London in January last. That scheme has now been circulated among the various national associations in the countries represented, and has been considered; but on Monday, May 13th, it was officially announced that the preparatory work is not yet far enough advanced to permit of a further meeting of the Preliminary Conference of the International Shipping Conference in July. As it would appear that the two months of August and September are inconvenient to many overseas constituent members of the Conference, it has been suggested that the next meeting of the Conference should be held in October. Last month it was hoped that the Conference might take place following that of the International Chamber of Commerce on June 24th to the 29th, but it now seems that it will be delayed till the autumn, as above indicated. We are given to understand that a large amount of detail is involved in the elaboration of the scheme, one of the objects of which is to raise the rates of freights to a level which will be generally remunerative. The scheme is made further complex by the fact that it embraces both liner and cargo services, and takes account of a variety of methods of determining rates of freight which are not the same in all trades.

British Aerodrome Survey.

RECENTLY a deputation from the Municipal Section of the Aerodrome Owners' Association was received by Lord Londonderry, the Secretary of State for Air, in order that the present position of internal air communications in Great Britain might be discussed. In particular, the delegation asked for information regarding the air routes proposed by the Air Ministry with the location of termini, intermediate landing grounds, and emergency landing grounds. The Air Minister's reply has been communicated to the Secretary of the Association. This statement points out that owing to unforeseen difficulties the scheme by which the Aerodromes Advisory Board had contemplated undertaking a national survey of air routes has had to be abandoned. Instead, the Air Ministry is making preparations to carry out the survey, and has reached an advanced stage in the matter. The information gained in the survey, the statement adds, will form a guide to the routes and location of aerodromes, and will remove operational obstacles in the path of aircraft operating companies. The Airport Owners' Association, while being asked to recognise the inevitable delay necessary before a detailed report on such a survey could be prepared, was advised that the acquisition of suitable sites for aerodromes should be undertaken as soon as possible by local authorities. While the size and dimensions of the aerodromes are intended to be as uniform as possible to ensure the safety of aircraft on night work, the equipment would vary with the class of airport. The situation with regard to the town served, being dependent on such local conditions as road and rail communications, town planning, &c., should be considered by the local authorities as being better qualified to judge the suitability of these matters.

Grit Trouble at Stepney.

WHILE much attention has been paid to the development of schemes for minimising the troubles arising from grit and other emissions from power station chimneys, stations that have not been provided with the most modern equipment continue to pollute the atmosphere. According to the London County Council's experts, the shaft associated with the pulverised fuel-fired boilers of the Stepney Borough Council's Limehouse station is liable, under normal working conditions, to discharge grit at the rate of nearly 4 cwt. a day, and legal action by the L.C.C. is under consideration. As far back as June, 1920, a local trader obtained an injunction against the Stepney Council and on appeal it was held that, even taking into consideration the character of the neighbourhood, the nuisance was a very real one. Although since that time the conditions have improved, further complaints began to be received from March last onwards, and observations maintained by the L.C.C. officers show clearly that the temporary measures put into operation are inadequate. Subject to the sanction of the Minister of Health, the Housing and Public Health Committee recommends that proceedings be taken against the Stepney Borough Council. While it is felt that everything possible has been done to persuade the Council to face its responsibilities, and while the members of the Public Health Committee are reluctant to recommend such a course against a responsible local authority, it is considered that the L.C.C. should now take legal action at the local police-court to secure an abatement of the nuisance.

The French Liner Normandie.

DURING the week from May 4th to May 11th the new 79,000-ton liner "Normandie," built at the Penhöet shipyard for the Compagnie Général Transatlantique, underwent successful trials off Belle Isle and in the Atlantic. According to the official statement, she exceeded a speed of 32 knots without her boilers developing their maximum power. In the cruising trials a speed of over 30 knots was easily maintained over a period of several hours, while satisfactory manœuvring and navigation tests were carried out. The fuel consumption at 28 knots was equal to that of the 43,500-ton liner "Ile de France" at 23 knots. The ship entered the harbour at Le Havre on the evening of Saturday, May 11th, and berthed alongside the new Maritime Station, the whole operation being completed in half-an-hour. During the progressive speed and cruising trials the liner carried a large number of shipyard workmen, who are completing the decorations in readiness for the ship's maiden voyage to New York, which will start on Wednesday, May 29th. It is of interest to record that all the first-class cabins on the ship have been booked for both the outward and return voyages, and that at the time of writing only a few tourist and third-class cabins are still available.

Accelerated Aircraft Construction.

MANUFACTURERS of aircraft and of aero-engines recently received a communication from the Air Ministry advising them of the possibility of considerable demands being made on their production in connection with the expansion of the Royal Air Force. In this communication the Air Ministry asked manufacturers to increase, as far as possible, their rate of working on contracts already in hand, so as to be in a position in the near future to place their entire production facilities at the disposition of the Government. The Ministry further inquired about any foreign or civil orders in hand or in prospect, and asked manufacturers to inform the Ministry before making any further commitments. It is understood that the communication referred to asks for data as to the maximum rate of production possible at each works and implies that this may be required for a period of about two years on the production of military aircraft.

British Trade with China.

THE first two Chinese apprentices to return to China after eighteen months' practical training in British engineering works under a scheme of scholarships sponsored jointly by the F.B.I. and the Chinese Association were entertained on Friday, May 10th, at a farewell luncheon by members of the joint committee of these two organisations. Lt.-Gen. Sir George Macdonogh, who presided, said that the first group of seven scholarship apprentices began their training in January, 1934. Of the two returning to China, Mr. Cheng-Yeh Chu was an electrical power plant engineer attached to the North-Eastern Electric Supply Company, Ltd., Newcastle-on-Tyne, and Mr. Hai-Tao Chang was a locomotive engineer, who received his training first with Craven Bros. (Manchester), Ltd., Stockport, in machine tools; later with the Hunslet Engine Company, Ltd., Leeds, in locomotive construction, and finally, for a few months, in the L.M.S. works at Crewe. Both apprentices had completed their training to the satisfaction of the companies concerned, and steps had been taken to secure suitable employment for them in China, through the F.B.I. Selection Committee in Shanghai. The other five apprentices will return to China later in the year. A further group of six apprentices arrived in this country last month for training at various engineering works under the F.B.I. scheme, and three more will arrive in June, making a total of sixteen during 1934–1935. So far the demand by British works for these scholarship apprentices has far exceeded the supply. Immediate results of a tangible nature could not, Sir George said, be expected, but it was to be hoped that the apprentices, acquaintance with the most modern British engineering standards and methods would enable them to rise to positions of influence in their country, and that British industry would thereby be enabled to secure greater opportunities for participation in the economic development of China.

A New Danish Bridge.

ON Tuesday, May 14th, King Christian of Denmark formally opened the new bridge for railway and road traffic which connects the island of Funen with Jutland across the Little Belt. The overall length of the bridge is about 1300 yards, and it is supported on four piers sunk into the clay bottom of the Little Belt, each of which weighs close upon 50,000 tons. The construction of the bridge was begun in 1929 and has been carried out by a group of Danish and German firms, the constructional steel work being supplied by the Rheinhausen Steel Works of Friedrich Krupp A.G. In a speech made at the bridgehead at Funen, the Danish Minister of Public Works, Monsieur Friis. Skotte, congratulated the designers and builders of the bridge. King Christian then officially opened the bridge and two streamlined trains drawn by oil locomotives passed over the bridge. The ceremony was broadcast to all Scandinavian countries and to Germany. The new bridge will make a seven hours' saving in the time for the journey from London to Copenhagen, which is now reduced to about thirty-two hours. It is of interest to recall that the design and construction of this remarkable bridge was described by Dr. Ing. Oswald Erlinghagen at a recent meeting of the Engineers' German Circle held in London.

The Late Mr. J. E. Storr.

ELECTRICAL and mechanical engineers in the North Midlands will learn with regret of the death of Mr. John Edwin Storr, of Leeds. Mr. Storr, who died at his home, "Lindum," North Park-grove, Roundhay, on Thursday, May 9th, had, since 1922, practised as a consulting engineer in Leeds and had carried out important contracts for municipal, industrial, and private concerns. He received his training at the works of Robey and Co., Ltd., of Lincoln, and on completing his apprenticeship spent some time at the Lincoln Corporation Electricity Works, after which he moved to the Croydon Electricity Works. After leaving Croydon, he was appointed a constructional engineer with Callenders Cable and Construction Company, Ltd., and on behalf of his firm carried out many contracts in London, in Lancashire and Yorkshire, and in Germany. After a short period with the Bolton Corporation, during which he was engaged upon constructional work, Mr. Storr was appointed to the staff of the Yorkshire Electric Power Company, a position which he continued to hold until 1922, when he set up in practice in Leeds as a consulting electrical and mechanical engineer. He was a member of the Institution of Mechanical Engineers, and a Past-Chairman of the North Midland Centre of the Institution of Electrical Engineers.

New Belgian Canal.

ON Monday, May 13th, the King and Queen of the Belgians embarked at Antwerp to open the new section of the Albert Canal, which runs from Antwerp to Herenthals, a distance of about 20 miles. The Albert Canal is the outcome of the rivalry between Rotterdam and Antwerp to capture the shipping trade of South-East Belgium, Alsace-Lorraine, and the North-East of France, as far afield as Nancy and Verdun, most of which is carried by the river Meuse and its tributory the Sambre. The Meuse, after Liège, widens and loses its depth, thus ceasing to be navigable. In order to give this river an outlet to the North Sea the Dutch constructed the South Willemsvaart Canal in 1826 on the left bank of the Meuse. After the separation of Belgium and Holland, the Belgians constructed a series of canals joining Antwerp to the South Willemsvaart Canal below Maastricht, where it becomes Belgian. In recent years the traffic on the Meuse has increased enormously, 140 boats a day passing Maastricht. Antwerp's share of such traffic has been 6,000,000 tons of shipping per annum. In 1925 the Dutch built the Juliana Canal on the right bank of the Meuse, which can take 2000-ton ships from Rotterdam entirely through Dutch territory. The threat to Belgian trade caused by this canal led to the construction of the Albert Canal. This joins the Meuse at Visé, and, traversing the rocky bank of the Meuse which had to be cut to a depth of 210ft. and a width of 130ft. for nearly a mile, follows the frontier through the Valley of Geer.

The Albert Canal.

No. I.

THE largest and most important public work now being carried out in Belgium is the construction of the Albert Canal, begun in 1930, which is to connect the Meuse near Liége with Antwerp. The second section of the canal, that extending from Petit-Lanaye to Lanaeken, which includes two chalk cuttings of great depth, was opened by the King of the Belgians and Queen Astrid on October 16th, 1934. Although a large part of the work remains to be completed and the details of the lay-out of at least one section have even now not been finally determined, those parts of the work which involve the heaviest construction have either been completed or are nearing completion. The river Meuse, which for long has been utilised for commercial navigation, serves an important industrial area, including the coal mines and iron and steel works of Liége and Charleroi. The Belgian Meuse is in a condition favourable for navigation as far as Liége. Below Liége, however, the inclination of the river becomes greater, its flow more rapid, and its sinuosities are more pronounced. It is only when Maasbracht in Holland is reached that the river begins to run through a flat and almost level plain.

As far back as 1823, when Holland and Belgium were united under the sovereignty of King William I, the construction of a lateral canal between Maastricht and Bois-le-Duc, called the Zuid-Willemsvaart, was begun. This canal, leaving the Meuse near Maastricht, rejoins the river near Crève-cœur in the Dutch province of North Brabant. It constitutes the chord of the large arc which the Meuse makes between Maastricht and Crève-Cœur—plan, Fig. 1. The canal was opened in 1826 and now accommodates barges carrying 450 tons or more. Later, the Liége-Maastricht Canal of similar capacity to the Zuid-Willemsvaart was made between 1845 and 1850. The junction canal from the Meuse to the Scheldt, opened in 1859, completed the system of navigable waterways for 450-ton barges, which was designed to connect the Meuse navigation with Rotterdam and Antwerp. Traffic on this system of waterways is, as we have already indicated, limited to craft carrying 450 tons whereas the Meuse above Liége can accommodate barges of 1350 tons and the normal capacity of the larger Rhine barges is 2000 tons. The Zuid-Willemsvaart, moreover, follows a somewhat erratic course, for it is, in fact, merely the enlargement of the irrigation cut made by order of Napoleon I in 1809 to carry the waters of the Meuse to the Grand Canal du Nord, which was to link the Scheldt with the Rhine. The total distance by the old canal route between Liége and Antwerp is 155 kiloms., the navigation comprising twenty-three locks.

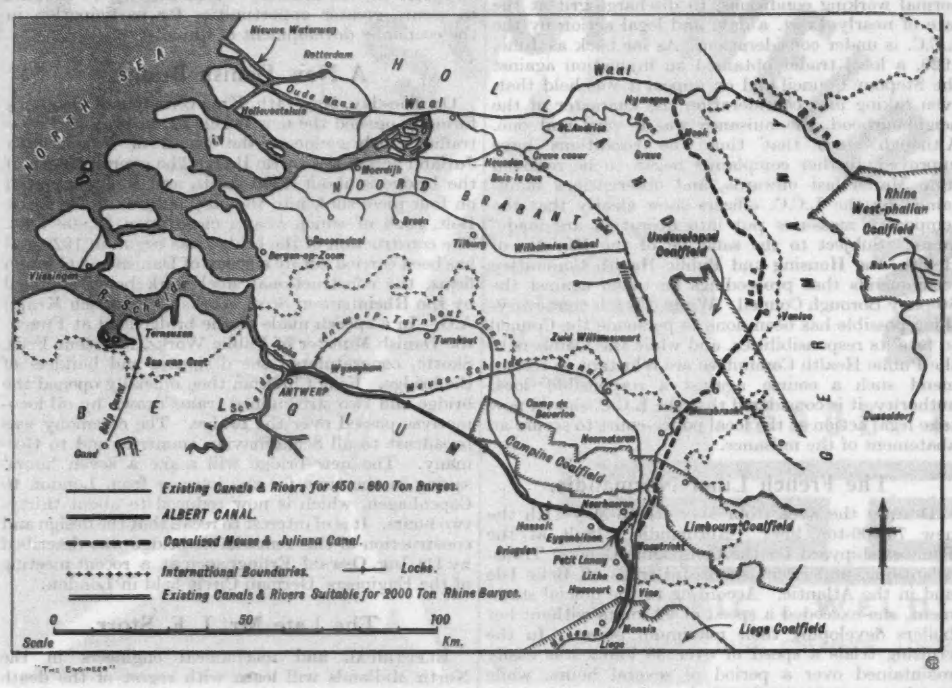


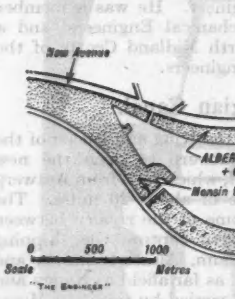
FIG. 1—CANAL SYSTEMS OF BELGIUM AND HOLLAND

The most serious obstacle to navigation between Liége and Antwerp is, however, the passage through the traffic bottle-neck at Maastricht in Dutch territory, where, in a stretch of 8½ kiloms., the canal makes a series of sharp turns in the neighbourhood of the old town fortifications, and numerous swing bridges and tunnels, three locks, and four Customs houses must be passed. It is said that it often takes from three to eight days for a barge to traverse this section of the navigation. In spite of these difficulties the traffic on the existing canal between Liége and Antwerp reaches a total of about six million tons annually on certain sections. The route of the present canal lies too far away from most of the collieries in the important Campine district to be of any service to them, and the development of this coalfield is one of the factors which has induced the Belgian Government to proceed with the making of the new waterway. Another factor of great importance is the supply of water; at present the intake of river water to the canals which link the Meuse with Antwerp is at Maastricht in Dutch territory, and the sharing of the water is strictly regulated by a Treaty of 1863. The new waterway will, however, be constructed entirely within Belgian territory, and will consequently be freed from all restrictions as to the intake of water as well as from the delays due to Customs control.

The problem of improving the navigation of the Meuse below Liége was considered by a mixed Dutch-Belgian Commission before the war; but after the war the project which had been under consideration was abandoned by Holland, and the Dutch Government in 1921 decided to construct the Juliana Canal entirely in Dutch territory. This canal—plan, Fig. 1—which is to take craft of 2000 tons capacity, is now nearing completion, and a section of it, that between Born and Maasbracht, was brought into use in May, 1934. The canal forms a navigation lateral to the Meuse between Maastricht and Maasbracht; below Maasbracht the Meuse has been canalised as far as Grave and is connected by means of the Maas-Waal Canal with the Waal at Nymegen, thus providing communication by 2000-ton barges between Maastricht and Rotterdam. The Belgian Government thereupon decided to study in detail a project for building a direct canal between Liége and Antwerp which would take barges of at least as great capacity as those to be accommodated on the Dutch canal between the Meuse and Rotterdam. The conditions laid down provided that the canal should be entirely in Belgian territory and its water supply was to be entirely from Belgian sources. It was to be capable of accommodating craft of 2000 tons carrying capacity so that all Rhine barges entering the Belgian Meuse by way of the Juliana Canal should be able to navigate to Antwerp *vid* the Belgian canal.* It was to have no dividing reach and was to be located as near as possible to the Campine collieries; furthermore, the number of locks was to be reduced to a minimum.

ROUTE OF THE NEW CANAL.

The navigation of the Meuse above Liége has recently been improved and the number of locks between Huy and Liége reduced from seven to three. It has been possible in the course of this improvement to raise the level of the Meuse at its exit from the city of Liége to +60·0 m.,† which level has been adopted as the water level for the first section of the new canal. The new Monsin Weir just below Liége creates a level reach at +60·0 m. of 17 kiloms., extending upstream through the city and the industrial district of Seraing. The Albert Canal takes its origin on the left bank of the Meuse just above the Monsin Weir—Fig. 2. From this point as far as Haccourt near Visé the new canal superposes the old Liége-Maastricht Canal, the embankments of which have been or are being raised and one of them set back in order to obtain the required depth and width. The existing swing bridges are now being replaced by fixed bridges. As soon as the water level in this section of the canal was raised, in May, 1934, to level +58·0 m., craft of 600 tons were able to navigate as far as Haccourt. The final raising to 60·0 m. is planned to be completed about 1937. A view of the



NOTE.—*The Canal Lock at Monsin will cease to be used (except as a regulating lock) when the water level in the Albert Canal below Monsin is raised to level +60·0 m. in 1937.*

FIG. 2—SITUATION OF THE MONSIN WEIR

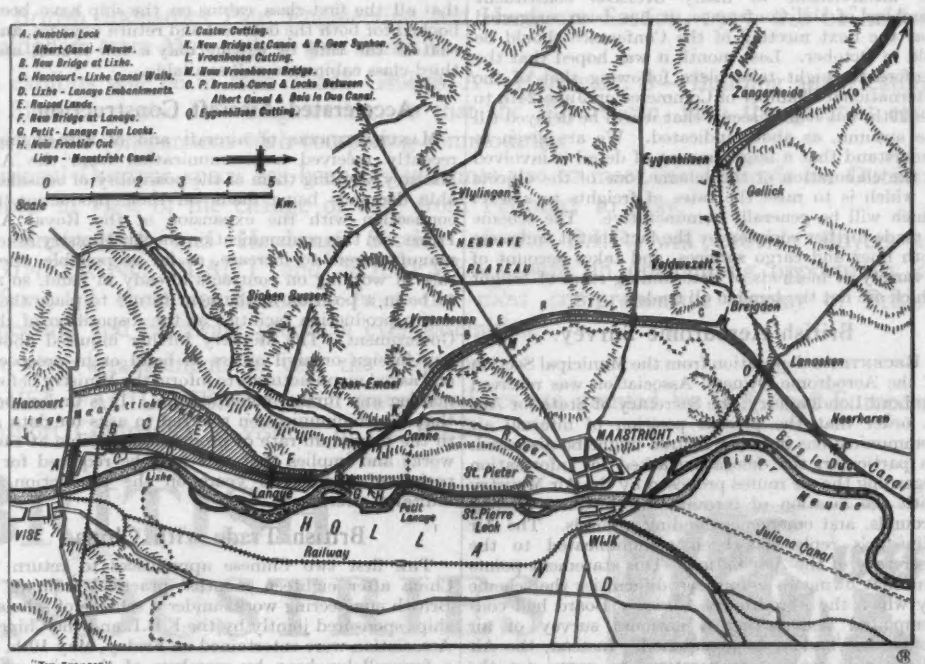


FIG. 3—PLAN OF ALBERT CANAL BETWEEN VISE AND EYGENBILSEN

* The only connection at present between the Juliana Canal and the Albert Canal is by means of the river Meuse at Maastricht and the locks at Lanaye; the latter are capable of passing barges of 600 tons capacity.

† All the levels given in this article are referred to the leve of mean low water at Ostend.

enlarged canal near Haccourt showing the water a little lower than +58·0 m. is reproduced in Fig. 9, page 514. At Haccourt a short length of junction canal and a lock have been constructed to form a connection between the new canal at level +60·0 m. and the Meuse at Visé, where the normal water level of the river is +52·75 m. At the Albert Canal end of the lock a large turning basin has been provided to facilitate the manœuvring of vessels.

Most of the schemes for the construction of a direct Liége-Antwerp canal, which formed the subject of study before the adoption of the finally selected project, left the valley of the Meuse at Haccourt and followed an almost straight line towards Eygenbilsen

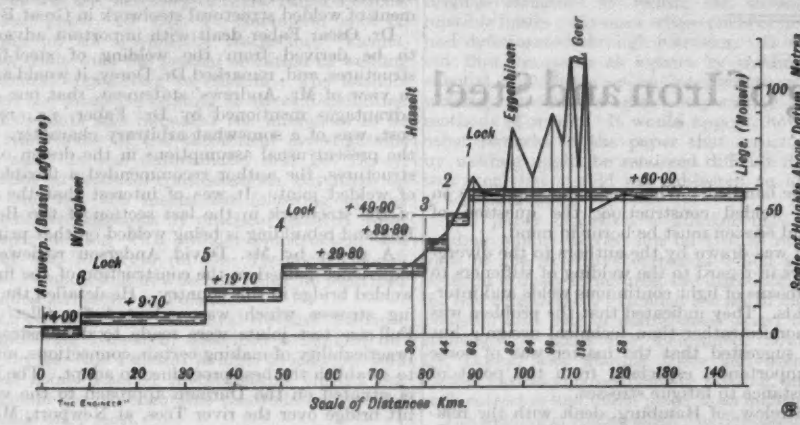


FIG. 4—CONTOUR OF ALBERT CANAL FROM ANTWERP TO LIEGE

over the high Hesbaye plateau, a dividing reach accessible from the Meuse by locks intervening between the Meuse valley and the low-lying country of the Scheldt valley. The question arose whether it would be practicable to adhere to this more or less direct route and at the same time avoid a dividing reach by maintaining the water level of the canal at +60 m. throughout the plateau. A plan of the Albert Canal between Visé and Eygenbilsen, which includes the site of most of the important works described in this article, is reproduced in Fig. 3.

Prolonged geological and engineering study showed the practicability of two alternative routes, one of

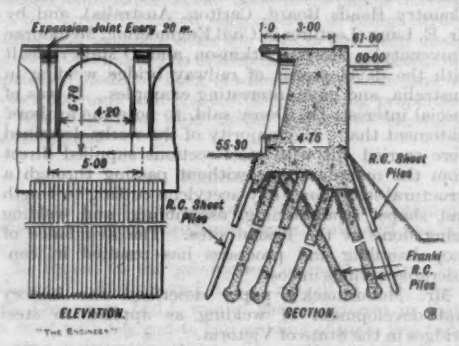


FIG. 5—HACCOURT-LIXHE CANAL WALLS

which passed through Sichen-Sussen with a dividing reach, and the other, less direct, followed the valley of the Meuse as far as Petit-Lanaye and beyond that ran close to the Dutch frontier as far as Briegden. This second alternative could be carried out in such a manner as to avoid a dividing reach, but its cost was estimated to be 300 million francs more than the first alternative owing to the heavy works involved in crossing the low-lying land of the alluvial plain and in making deep cuttings through the high plateau. The second route possessed the additional advantage of being more suitable for linking up with junctions serving the eastern part of the Campine coalfield and, moreover, it was considered by the Belgian War Office that the canal cuttings along the Dutch frontier would form a better line of defence than a canal with a dividing reach in the region of Sichen-Sussen. It was this second alternative that was finally adopted in 1928 by the Belgian Government and the Albert Canal as now being built will have no dividing reach and only six locks between the Meuse at Liége and the docks at Antwerp—Fig. 4.

HACCOURT-LIXHE WALLS.

From Haccourt northwards the water level of the new canal is 7·25 m., and further on 10 m. above the general level of the alluvial plain of the Meuse. At Haccourt itself there was insufficient space for the construction of an earth embankment between the left bank of the canal and three existing cement works which lie close alongside the old canal for a distance of nearly 1600 m. It was therefore decided to construct the left bank of the new canal in the form of a quay wall, 1800 m. long, leaving between it and the right bank a space for the canal 72 m. wide. The left bank wall was constructed with special care in order to avoid the possibility of percolation and undermining which might be harmful to the cement works which adjoin the canal. The soil is permeable; beneath a layer of alluvial silt, 1·5 m. to 2 m. thick, is a bed of Meuse gravel which becomes coarser in character as the depth below the surface increases.

The foundation for the wall consists of Franki reinforced concrete piles, nearly all of which are inclined. Four thousand of these piles were sunk as a foundation for the wall, their average length being about 8 m. (Fig. 5). The reinforcement of these piles is carried up into the mass concrete wall which is supported by them. On each side of the Franki foundation piles is a screen of reinforced concrete sheet piles. The screen on the canal side of the wall is intended to prevent the undermining of the wall structure, and that on the outer side prevents the percolation of water, the gravel mass behind it, and under the superstructure, having been injected with cement grout to form a water-tight monolith. The superficial area of the sheet piling is 28,000 square metres. The superstructure wall is built in panel

FIG. 7—CROSS SECTION OF CANAL AT HACCOURT

lengths of 20 m., the junction plane between adjoining panel lengths containing two vertical joint grooves which have been filled with bitumen. Steam pipes were inserted in the core holes during the pouring of the bitumen in order to ensure the free flow of the material. The wall on the right bank of the canal at Haccourt, 600 m. in length, is also built on Franki piles with a screen of reinforced concrete sheet piles below the superstructure on the canal face only. This wall is, however, backed by filling material (Fig. 7).

LIXHE-LANAYE EMBANKMENTS AND RECLAMATION.

Following the canal northwards it crosses the low-lying ground from Lixhe to Lanaye between embankments (Fig. 6). Considerable care has been taken to prevent the loss of water through these embankments, that on the right bank having a length of about 6 kiloms., consists of an impervious mass A resting on ground cleared of turf and vegetable earth. Two longitudinal trenches were first cut in the ground and afterwards filled with impermeable material to form "cut-offs." The water-tight prism A consists of a clay-gravel mixture containing 40 per cent. clay and 60 per cent. gravel, laid in layers 15 cm. thick, and consolidated by 8-ton caterpillar rollers. On the outer slope of the water-tight prism the embankment consists of selected earth rammed and rolled like that in the impervious mass. The remainder of the embankment consists of ordinary spoil on which a layer of vegetable earth, 30 cm. thick, has been laid. On the left bank (west side) of the canal the alluvial plain has been raised to a level of +61·5 m. or +62·0 m. over an area of about 170 hectares, and here again care has been taken to secure the water-tightness of the material adjoining the canal bank.

The construction of the canal embankments and the raising of the surrounding land in the valley of the Meuse between Haccourt and Petit-Lanaye involved the deposit of 6,000,000 cubic metres of spoil on the right bank of the canal and 15,000,000 cubic metres on the left bank, including the quantity required to raise the surface of the valley between the chalk cliff and the canal by about 10 m. This great mass of filling material, 21,000,000 cubic metres in all, comes from the cuttings described hereafter, which have been made between the valleys of the Meuse and Geer, and further on in the Hesbaye plateau, which lies between the Geer valley and Briegden.

The canal between Lixhe and Lanaye has a variable width up to a maximum of 64 m. on the water line, and up to 52 m. at level +56·0. The minimum bottom width is 32 m. The canal banks are protected by concrete slabs at and near the water line. The construction of this protective work is seen in the photographic view, Fig. 11, page 514.

WORKS AT PETIT-LANAYE.

Beyond the alluvial plain at Lanaye, the river Meuse approaches the chalk cliff which forms the eastern escarpment of the high plateau. From the bridge at Lanaye onwards, the space between the old Liége–Maastricht Canal and the cliff was taken up by the Petit-Lanaye cement works, and, a little further on, the river Meuse runs close alongside the canal. As the river constitutes the international frontier, any diversion of its course was impossible. Moreover, the actual boundary line is the *thalweg* of the river, *i.e.*, the line of greatest depth which at this point runs very close to the concave or left bank of the stream. Several alternative projects for overcoming the formidable difficulties with which the engineers were faced on this section of the work were considered. Ultimately, the cement works were purchased by the State at a cost of 30 million francs. This made possible the adoption of the best of the alternative plans, namely, one which provided for the construction of a large turning basin (Fig. 12, p. 514) at the junction of the main Albert Canal, where it enters the Meuse-Geer (or Caster) cutting, with a short branch canal leading to the locks which link the Albert Canal and the Dutch section of the old Liége-Maastricht Canal.

FIG. 9—LIFT GATE OF PETIT-LANAYE LOCKS

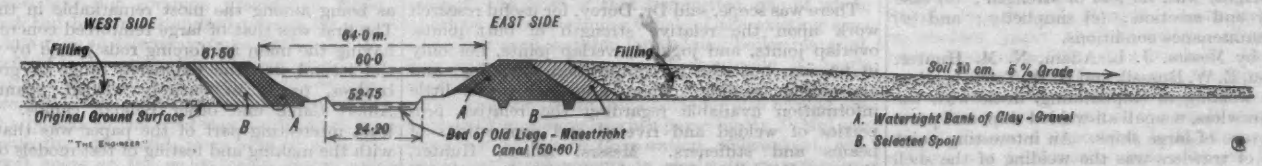


FIG. 6—CROSS SECTION OF CANAL EMBANKMENTS FROM LIXHE TO LANAYE

The raising of the water level of that part of the Liége–Maastricht Canal, which is incorporated in the Albert Canal, to +60·0 m. made it necessary to build locks which would overcome the difference between the higher level of +60·0 m. and the water level of the Meuse at Maastricht, which is +46·4 m. The twin locks which have been built have internal dimensions of 55 m. × 7·5 m. in the clear, the lift in each lock being 13·6 m. The two lock chambers are placed side by side. Between the locks and the international frontier the existing canal will be modified to conform with alterations in water levels, which will be brought about when the Dutch Government proceeds with the reconstruction of the frontier reach of the Liége–Maastricht Canal. This proposal

involves the suppression of an existing lock (Saint Pierre) near Maastricht and the establishment of the Maastricht reach of the canal at level +46·4 m., which is the normal level of the river which here flows alongside the canal. In the meantime, the Petit-Lanaye locks are being operated on the existing downstream water level, viz., +49·4 m., the lift being 8·6 m.

The lock sluices have been arranged so that water may pass from one of the twin chambers to the other, thus reducing, as far as possible, the consumption of water. The upstream gates are mitred and the downstream gates are raised and lowered from an overhead structure. The downstream head of the lock structure is crossed by a fixed bridge, and below the locks a large basin is being built for the purpose of facilitating the manœuvring of craft and Customs examination. Views of the Petit-Lanaye twin locks are reproduced in Figs. 8 and 10 on page 514. The latter shows the locks and the overhead structure before water was let into the canal with the Meuse in the background. The other view shows one of the lower gates partly raised for the passage of a barge. Fig. 12 shows the wide basin south of the junction of the short branch with the main canal.

(To be continued.)

Symposium on the Welding of Iron and Steel

No. I.

THE symposium on the welding of iron and steel, organised by the Council of the Iron and Steel Institute, in co-operation with fifteen other technical societies, and at the request of the Department of Scientific and Industrial Research, occupied two days, Thursday and Friday, May 2nd and 3rd, in the Great Hall of the Institution of Civil Engineers.

The work of the Organising Committee resulted in the presentation of about 150 papers, on various aspects of the welding problem, from Great Britain and the Dominions and many foreign countries. The numbers attending the meetings varied from about 700 to a little over 900, including many delegates from overseas. Naturally, in view of the number of papers obtained, it was necessary to group them, each group being presented by an expert on the particular subject, who surveyed it briefly. The great majority had already been circulated, but a few, which were not received in time for printing, will be circulated in the near future. Ultimately, it is anticipated that the papers and full discussions will be published in two volumes, and at the end of the symposium it was intimated that already some 500 orders had been received for these volumes.

Professor Sir Harold Carpenter, F.R.S. (President of the Organising Committee of the symposium), said that the matter had arisen more than a year ago, when the Metallurgy Research Board, whose function is to advise the Department of Scientific and Industrial Research, adopted a suggestion made originally by Dr. H. J. Gough that welding was not receiving in this country the scientific attention it deserved, and made a recommendation in that respect. The Department, therefore, had asked the Iron and Steel Institute to organise a symposium, and the Institute had secured the co-operation of fifteen other societies, having a total membership of something like 100,000. After the conference it was the intention of the Organising Committee to consider the papers and discussions, and to advise the Department as to what further work should be done and assisted.

GROUP I. (A). WELDING IN THE ENGINEERING INDUSTRIES.

The Thursday morning session was devoted to the consideration of a series of papers concerning present-day practice and problems of welding in the engineering industries, the particular aspects covered being bridge and structural engineering, pressure vessels, railway material, and shipbuilding.

Dr. S. F. Dorey (of Lloyds' Register of Shipping) acted as reporter and briefly surveyed the papers.

Shipbuilding.

Taking shipbuilding first, he said the papers dealt with welding development in regard to ship construction in Great Britain, Germany, and the United States. In general, the authors had drawn attention to the main advantages to be derived from the adoption of welding. They appeared to be (*a*) saving in weight, with no loss of strength; (*b*) ease of assembly and erection; (*c*) simplicity; and (*d*) improved maintenance conditions.

A paper by Messrs. J. L. Adam, N. M. Hunter, S. B. Ralston, E. W. Russell, and H. W. Townshend on electric arc welding in shipbuilding, dealt with the welding of trawlers, a small all-welded ship, and parts of the structure of large ships. An interesting point in the case of trawlers was the welding of the shell protective mouldings which were subject to blows from fishing gear, and were a common source of trouble when riveted. Other parts of the vessel to which welding had been applied included deck plating, which had decidedly improved water-tightness, beam knees, gunwale bars, tanks of shapes impracticable with riveted construction, bulkheads, engine seatings, hatches, deck erections, skylights, &c. Completed sections of deck embracing beams, beam knees, stiffeners, and gunwale bars had been erected, along with stiffening, butt welds being employed wherever possible.

In the case of large ships, the authors gave a detailed list of the parts considered suitable for welding, with a brief description of the procedure adopted for each part. It was noted that the lifting capacity of cranes limited the size of complete welded sections that could be handled. When reducing scantlings on account of welded construction, the question of corrosion and erosion must be borne in mind.

Attention was drawn by the authors to the divergence of views in regard to the welding of stiffeners to plating by means of light continuous welds and intermittent welds. They indicated that the problem was one of economics rather than technical design; but Dr. Dorey suggested that the matter was of some technical importance, especially from the point of view of resistance to fatigue stresses.

Dr. W. Strelow, of Hamburg, dealt with the relative merits of bare and covered electrodes. It appeared that the bare electrode was favoured for ship work in Germany; and the author considered that with such electrodes there was a better possibility of obtaining reasonably sound welds. He pointed out that there was no slag to attend to, and there was less heat effect than with covered electrodes. He conceded, however, that better physical properties could be obtained with the latter type of electrode, but experience had shown that bare wire was quite good enough for most ship work.

A paper which might be considered in conjunction with those in the shipbuilding sections was one presented by Mr. D. E. Baldwin (Melbourne, Australia), who described the electrically welded oil barge "Comor," 125ft. by 32ft. by 12ft., 600 tons deadweight. This vessel was welded from stem to stern, and was constructed to class with Lloyd's. Although no effort was made to reduce weight—indeed, to suit the convenience of the owners, the scantlings were based on riveted standards—the saving in weight was 10 per cent., and the saving in cost at least 15 per cent. All joints in the hull were of the reinforced butt type, with the exception of the centre keel plate and the curved plates at the bow and stern. The author pointed out that the butt type of joint permitted of a reduction in the skin friction of the hull. The lap joints of the keel, stem, and stern permitted inaccuracies in fabrication to be overcome without undue cost, as a slight variation in the lap was of no importance. The author suggested that the combination of lap and butt joints provided a solution of the problem of constructional inaccuracies. Another suggestion by the author was that a marked economy could be made if rolling mills would supply shapes designed to take the utmost advantage of the welding method. An interesting section of the paper dealt with welding technique and the methods adopted to avoid distortion troubles.

In general, said Dr. Dorey, these papers emphasised the importance of adopting a proper welding system or sequence for ships. The basic principle of any system was the avoidance of cumulative shrinkage effects which might result in the lifting of the bow or stern, or even in giving a twist to the entire hull. Another important factor involved in all structural work in which distortion was to be avoided was the making of joints with the minimum deposition of weld metal consistent with strength.

There was scope, said Dr. Dorey, for useful research work upon the relative strength of butt joints, overlap joints, and joggled overlap joints, not only in tension, but also in compression, buckling, and alternating bending. There appeared to be little information available regarding the relative properties of welded and riveted end connections of beams and stiffeners. Messrs. Adam, Hunter, Ralston, Russell, and Townshend pointed out that it was of immediate importance that accurate data should be available as to the relative values of stiffeners without faying flanges welded to plating and riveted stiffeners of normal form.

Bridge and Structural Engineering.

There were nineteen papers in this section, the whole containing information from many parts of the world, including Great Britain, Australia, Canada, Belgium, Czechoslovakia, Germany, Italy, Poland, Austria, and Sweden.

Dr. H. J. Gough presented a paper summarising the history, objects, and research activities of the Steel Structures Research Committee (formed by the Department of Scientific and Industrial Research) in regard to welding. An important section of the paper dealt with an investigation of non-destructive field tests for welded joints; X-ray, magnetic, electrical, and stethoscopic methods were considered. Dr. Gough stated that the electrical resistance tests, whilst showing some relation to the magnetic and X-ray tests, were not very successful, and that the present indications were that magnetic methods offered greater hope of successful application to structural work than electrical methods.

It was suggested by Mr. Ewart S. Andrews, who presented a paper on the welding of structural steelwork for buildings, that the cost of welded construction could not, as yet, compete with riveting. In the circumstances, he considered that the official authorities could not be blamed for the slow development of welded structural steelwork in Great Britain.

Dr. Oscar Faber dealt with important advantages to be derived from the welding of steel-framed structures, and, remarked Dr. Dorey, it would appear, in view of Mr. Andrews' statement, that one of the advantages mentioned by Dr. Faber, *i.e.*, reduced cost, was of a somewhat arbitrary character. With the present usual assumptions in the design of steel structures, the author recommended a flexible type of welded joint. It was of interest that the whole of the steelwork in the last section of the Bank of England rebuilding is being welded on that principle.

A paper by Mr. David Anderson reviewed the experience gained in the construction of the first all-welded bridge in this country. He detailed the working stresses which were adopted for fillet welds. Full-size test joints were made to demonstrate the practicability of making certain connections, and also to establish the best procedure to adopt. The bridge is situated on the Durham approach to the vertical lift bridge over the river Tees, at Newport, Middlesbrough. It has five spans, varying between 28ft. and 64ft. long, a roadway 38ft. wide, and two footpaths, 9ft. wide.

Messrs. C. Helsby, C. W. Hamann, and F. J. Samuely presented a paper with the object of pointing out where welding design differed from riveted design, and also indicating the trend of steel construction owing to the influence of welding.

A paper by Mr. G. Roberts (of Dorman, Long and Co., Ltd.), on the design and tests of butt-welded joints was referred to as of special practical interest. It discussed the essential features governing the strength of butt-welded joints.

From Australia, papers were presented by Messrs. A. S. Atkinson and C. J. O'Malley (Board of Land and Works, Melbourne), by Mr. W. T. B. McCormack (Country Roads Board, Carlton, Australia), and by Mr. E. Lang (Lecturer in Civil Engineering, Melbourne University). Messrs. Atkinson and O'Malley dealt with the development of railway bridge welding in Australia, and gave interesting examples. It was of special interest, Dr. Dorey said, to note the authors' statement that "the majority of the works described were carried out with steel sections supplied direct from the manufacturers without passing through a structural steel shop; oxy-acetylene cutting to length and shape, straightening, assembling, and welding being done at the bridge sites. The avoidance of shop handling and processes has resulted in considerable savings in cost."

Mr. McCormack's paper described the history and development of welding as applied to steel bridges in the State of Victoria.

From Canada, a paper was presented by Mr. R. S. Eadie (of the Dominion Bridge Company, Ltd.). The author reviewed the advantages of steel-concrete composite construction, which, he stated, combined the best features of both reinforced concrete and structural steel, for building purposes. Mr. Eadie detailed the special advantages of that type of construction over ordinary reinforced concrete and mentioned the essential factors in design and erection. He described also the addition to the Western Hospital, Montreal—a ten-storey building, relatively narrow compared with its height.

Professor H. Dustin (of Brussels University) presented a paper with the object of drawing attention to two very different fields wherein the achievements of Belgian engineers and contractors might be claimed as being among the most remarkable in the world. The first was that of large reinforced concrete works having the main reinforcing rods joined by welding; the second was the extensive range of great steel bridges, partly or entirely welded, spanning the Albert Canal and other Belgian canals. Not the least interesting part of the paper was that dealing with the making and testing of test models of various parts of a structure.

Dr. F. Faltus (of the Skoda Works, Pilsen, Czechoslovakia), whose paper discussed the design of welded structures with special reference to erection on site, pointed out the advantages of welding large units in the shops. He described how to build up a lattice girder on site, indicating the best positions for making the required connections, and pointed out that the design must take into account the problems of assembly.

The purpose of a paper by Mr. H. Maier-Leibnitz (of Stuttgart) appeared to be to draw the attention of structural engineers to a form of portal or arched girder to cover halls of large dimensions. He had not the space to deal with the subject comprehensively, but it was felt that he had shown the important advantages to be derived from solid webbed welded

construction. He was of opinion that there was room for further experiment and research in regard to the design and construction of frame shoulders.

A paper by Dr. G. Schaper (of the German State Railways) contained a list of what he considered to be established facts and principles in regard to the application of welding to building and bridge work.

Dr. Fausto Masi (of Italy) referred to the impetus given to the construction of steel buildings in Italy by the introduction of welding. He appeared to favour tubular construction for trussed structures, and mentioned the factors which he considered to be essential in design. Dr. Masi did not consider that there was any necessity to revise rolled sections.

Another paper, by Drs. F. Hartmann and K. Girkmann (of the Technische Hochschule, Vienna, Austria), dealt with the present situation of welding in structural engineering in Austria. The authors discussed the problems relating to stress distribution in welded joints and indicated the inferences to be drawn from some of the theoretical investigations carried out. It was unfortunate, said Dr. Dorey, that, owing to financial considerations, our Austrian friends had not the means for following up the theoretical investigations by practical research work.

A paper dealing with tubular construction was given by Dr. S. Bryla (of the Technical School, Warsaw, Poland), and in a second paper he described four welded structures in Poland.

Mr. D. Arvidsson (of the Royal Swedish Institute for Engineering Research) described a modern all-welded bridge—the Palsund Bridge, Stockholm, and discussed some detailed investigations carried out to determine the most suitable electrode for welding high-tensile alloy steel.

Discussing the future development of welding as applied to bridge and structural engineering, Dr. Dorey said it would be necessary to carry out a great deal of research work. It was apparent from the papers, he said, that investigations should be made into the fatigue properties of welded joints and connections used in structural steelwork, especially in regard to bridges likely to be subjected to repeated stresses resulting from heavy live loads.

There were very few fatigue testing machines in existence capable of dealing with representative samples of welded assemblies. It seemed that some thought should be directed to the problem of devising fatigue-testing machines suitable for this purpose.

Research was also required into the resistance of welded joints to corrosion. Some of the papers referred to the severe corrosion encountered in bridge structures, and in many cases the defects had been made good by welding. The conditions which had produced corrosion had not been eradicated, however, and it was important that the corrosion-resisting properties of the deposited weld metal should be carefully investigated.

Railways.

Papers in this section covered the production of rails and bridges, structural repair work, and welded rolling stock.

In regard to the production of rails, a paper by Messrs. E. Rietsch and A. C. Croskell (A.E.G. Electric Company, Ltd.), was of special interest in that it dealt with the end-to-end welding of main line rails by the resistance method. The authors pointed out that in view of the present-day demand for high speeds in railway transport, it was necessary to cut down the number of joints in a rail track. Obviously, the stresses set up in an ordinary gapped rail, owing to the wheel striking the following railhead in a downward and oblique direction, were entirely absent in a welded rail. That, said the authors, was of great importance when it was desired to eliminate the impacts on bridges and the resonant vibrations that resulted therefrom.

A brief description of the flash resistance welding process was given, and emphasis was laid on the importance of automatic temperature regulation during welding.

It appeared, said Dr. Dorey, that that method of welding rails was not common practice in Great Britain, but had been the standard process for joining main line rails in Germany since 1928. An important item of information derived from experience in Germany was that, although hardness tests revealed that the weld face was comparatively soft, whilst the rail metal adjacent to the weld was harder than the metal remote from the weld, there was no development of soft spots at the welds under traffic conditions.

It was noted from the paper that under modern conditions the rails were stressed up to 14 tons per square inch. In dealing with the problem of allowing for longitudinal expansion, the authors referred to experiments showing that in a welded rail, 153ft. long, in which expansion was prevented, a compressive stress of 61,000 lb. (27 tons) per square inch was obtained in the rail when heated to 105 deg. Cent. The authors suggested that compressive stresses could be avoided by laying welded rails in hot weather or by artificially heating them, the result being that tension stresses only would be applied to the rails in cold weather. Particulars of long lengths of welded rails were also given.

A paper by Messrs. G. Ellson and J. Miller (on behalf of the G.W.R., L.M.S.R., L.N.E.R., L.P.T.B., and S.R.) dealt in the main with electric welding repairs carried out on rails and bridges. The authors stated that the practice of making good the surface of worn crossings by welding *in situ* had been developed on all railways in this country, and many thousands of crossings had been thus treated. A matter of considerable interest was the use which was made of the magnetic testing method for examining rails for surface defects.

In regard to bridge and structural repair work, the authors considered the subject under two heads, viz.:—(1) Cases where, owing to the members of the structure being of insufficient strength to carry present-day loads, material had to be added to the original structure to reduce the stresses to permissible limits; (2) cases where parts of the structure had deteriorated through corrosion. It was pointed out that inasmuch as repairs by welding could be effected with little or no interference with traffic, welding attained a great superiority over other methods of repair. It would appear, however, from other remarks in the paper that structural repairs by welding might be rendered difficult if the traffic was such that a weld was subjected to loads before it was completed.

The paper described a number of examples of welding repairs carried out on British railways. In view of the extensive corrosion which appeared to occur in railway structures, the introduction of welding had considerably extended the life of various components, and had in many cases saved the cost of renewal. A point not mentioned, however, said Dr. Dorey, was whether there had been cases of further corrosion subsequent to welding, and whether such corrosion had taken place at an increased rate.

The welding of rolling stock was discussed in a paper by Mr. M. Moe (Norwegian State Railways), who showed the development of welding both for repair work and for construction on those railways. It indicated that the welding of copper fire-boxes for locomotives was first undertaken eight years ago, and that no defects had since occurred. The welding was done, presumably, by the oxy-acetylene process. Attention was drawn to the fact that the Norwegian State Railways are using butt welded joints when replacing defective boiler plates.

The paper dealt in detail with the fabrication of wagons. The author stated that those now in service had not been in use for more than two years, so that operating experience was rather limited.

As to passenger coaches, three electric rail cars with four trailers had recently been built. On these, both the underframes and the bogies were welded, but the remaining part of the car body was of wood. The author considered it possible that building these coaches by means of welding might reduce the weight from 50 to about 35 or 40 tons, using ordinary mild steel.

The paper indicated that there was considerable scope for the application of electric arc welding to rolling stock.

Pressure Vessels.

Papers in this section comprised a comprehensive survey of the position in regard to pressure vessels in Great Britain, Australia, and the United States.

Mr. C. H. Davy (Babcock and Wilcox, Ltd.), presented a paper concerned mainly with welding problems in relation to boiler drums. He traced the history of welding development and revealed the advantages to be derived from welded construction when the welding was carried out under rigid control and a complete testing and inspecting procedure. Not the least important section of the paper dealt with testing and inspection. The author's remarks on heat treatment were of special interest, particularly his reference to the possibility of spheroidisation taking place at temperatures between 650 deg. and 700 deg. Cent. He also emphasised the importance of X-ray examination of welded seams. Fusion-welded boiler drums operating at 700 lb. per square inch were mentioned.

Professor F. C. Lea (Chairman of the Institution of Mechanical Engineers' Welding Research Committee) reviewed the work of that Committee, one of whose functions is to determine which of the existing electrodes are most suitable for welding boiler material. How that information would eventually be made available, commented Dr. Dorey, was not stated.

The question of suitable electrodes also formed one of the chief considerations in a paper by Mr. T. McLean Jasper (A. O. Smith Corporation, Milwaukee), who traced the developments in electrode manufacture, and included some tests which could be obtained consistently with up-to-date methods of welding. The author stated that the latest development in weld-rod coatings produced a reducing atmosphere, which not only blanketed the welding operation and kept the atmosphere from contaminating the deposit as it travelled through the arc, but reduced certain impurities contained in the electrode metal and rendered the deposit solid, strong, very tough, and considerably more resistant to corrosion than the plate material.

Those words, said Dr. Dorey, were optimistic, but there could be no doubt that the future high-class electrode suitable for pressure vessels must conform to such an ideal, especially as it was the modern tendency to increase the size of electrode used and the ampèrage in the arc. Those factors were mentioned in a paper by Mr. W. D. Chapman (E.M.F. Electric Company, Pty., Ltd., Melbourne), who devoted the larger portion of his paper to the development of procedure control in Australia.

A paper by Mr. E. R. Fish (Hartford Steam Boiler Inspection and Insurance Company) set out the present position in regard to the welding of pressure vessels in America. Considerable headway appeared to have been made, and it was stated that "all insurance companies in the United States accept without hesitation welded boilers and unfired pressure vessels when built in conformity with the recognised specifications."

In regard to the classification of welded pressure vessels, it appeared to be the American practice to grade the test requirements according to the service for which the vessel was intended. In the highest class of work X-ray examination was required. Mr. Fish referred to the welding of pipe lines *in situ*, and pointed out that a very high degree of skill was required on the part of the operators.

That subject was also dealt with by Mr. D. Ross (South Durham Steel and Iron Company, Ltd.), with particular reference to a few of the many large diameter steel pipe lines in this country, welded by the water gas process and by the electric arc process. Discussing the electric welding of the circumferential seams, Mr. Ross observed that "experiments were made with the use of 6-gauge electrodes for building up fillet welds after sealing runs had been made, but the excess heat and consequent contraction necessitated the discarding of the 6-gauge rods in favour of rods of smaller size."

The Lochaber and Tummel penstocks were fully described in the paper. That at Lochaber consists of two pipe lines, each 3000ft. long, ranging from 70in. to 63in. diameter; that at Tummel of two pipe lines each 630ft. long by 12ft. 6in. diameter. The maximum test pressure was 100 lb. per square inch. Those were believed to be the largest welded pipe lines in this country.

Messrs. N. P. Inglis and W. Andrews (Imperial Chemical Industries, Ltd.) dealt with the application of welding in the chemical engineering industry, and pointed out the adaptability of welding for coping with developments and alterations in chemical plant. In regard to pressure vessels, they stated that welding design and technique were not regarded in the chemical industry as affording a safe and reliable method of construction for large high-pressure containers (up to 4000 lb. per square inch). They visualised the possibilities of welding in the future, but advocated a cautious policy in the meantime. A welded air receiver operating at 100 lb. per square inch was mentioned as an example of the present position. They had a decided preference for the resistance method for welded pipe joints and recommended its use for the highest pressures encountered in present-day practice.

Those authors also introduced the question of welding high-tensile alloy steels. It appeared that two of the main difficulties in the way of welding such steels were (1) inability to refine the grain structure of alloy weld metal by heat treatment, (2) the necessity for correcting by heat treatment the effect of the welding heat on the properties of the parent metal. It was suggested that research data and information were required on those points.

A paper by Mr. H. H. Hollis (Oxley Engineering Company, Ltd.) was of special interest to those concerned with the construction and operation of gasholders. The author stated that the electric welding of gasholders was not applied extensively in Great Britain, and he attributed that to conservatism on the part of gas engineers and public bodies. A number of repairs which served to demonstrate the advantages of electric welding over riveting in repairing gasholders were described. It was disturbing, said Dr. Dorey, to note the author's remark that in the course of his inspecting duties in this country he had found many riveted gasholders in a deplorable and dangerous condition. By adopting welded construction with butt joints instead of riveted joints, trouble caused by corrosion at joints would be eliminated.

Messrs. N. Fernie and R. J. Keating (Water Supply Department, Northam, Australia) described in another paper the application of welding to renovations of a 30in. steel conduit. Mention was made of the serious leakage resulting from internal and external corrosion of such pipe lines. A number of conclusions were given as the result of experiment, one of the most important being that, in electric welding, the best results were obtained from high-class electrodes and multiple runs.

The papers as a whole, said Dr. Dorey, comprised a unique summary of the present position of welding in all parts of the world. Discussing welded pressure vessels, he said he was informed by a colleague in America that the American Navy had something like 600 welded boiler drums under construction or in service; the insurance companies there favoured the welded as against the riveted drum, and no increased premium was required for welded pressure vessels.

Discussion.

Mr. J. L. Adam (British Corporation Register of Shipping and Aircraft) said that an immediate commercial difficulty in regard to shipbuilding was that we did not know the respective merits of beams

welded or riveted to plating. It was pointed out in the paper on electric arc welding in shipbuilding that unbracketed stiffeners attached to plating were reinforced for 15 per cent. of the length of the stiffeners; that applied only in passenger ships, and the two British classification societies required only a short reinforcement at the ends of such stiffeners in cargo ships. The 15 per cent. had crept in as a Board of Trade regulation because that was the figure laid down for riveted stiffeners; that 15 per cent. length for riveted stiffeners was only a convenient, not a scientific, way of getting the extra attachment at the end of a riveted beam. An authoritative statement should be forthcoming showing those who guided our destinies how they might allow us to economise in the construction of ships. Mr. Adam questioned the statement by Dr. Strelow that bare wire welding had proved effective in German shipbuilding. Even in the small ships in which it had been used so far, one could not say that it would prove successful until it had been subjected to the complete changes that occurred in a ship throughout the years; there had been indications so far that bare wire welding was not good enough in a ship structure.

Mr. F. J. Samuely discussing the economics of welding structures, referred to a rather large all-welded structure recently built in England showing prices per ton that were just about the same as the prices for a similar structure riveted, and the tonnage was much smaller in the welded construction, so that one could really say that, on the whole, welded construction was cheaper than riveted construction. A difficulty was that construction firms tried to use old machinery, and he suggested that the machinery used should be designed by the engineer responsible for the structure. One of the best features of welding was that the engineer was not bound to use particular sections, as in riveted construction, but could combine all sorts of sections, including the T, and the round bar.

Mr. P. L. Roberts said that difference of opinion as to whether or not bare wire welding was suitable for shipbuilding arose from the general nature of the statements made. From a considerable experience of comparing the two types of electrode, he warned investigators to be very careful in the application of bare wire. A general investigation into the comparative values of the two types of electrodes for the more common joints would yield a great deal of assistance to industry. One difficulty with the bare wire weld was that it had very little elongation, and if it were used in big structures or in structures which were rigid or partially rigid, one might experience great difficulty owing to contraction cracks.

Mr. Ewart S. Andrews (President of the Institution of Structural Engineers) said that if the industry really did wish to introduce welding into structural steel work the existing large constructional firms must organise themselves to carry out the work on the large scale on which it would have to be done, if in fact they could do it more cheaply than riveted work.

Dr. Dörnen (Germany) referred to the bridge over the Rüegen Dam as being the most interesting of the latest examples of welded construction in Germany. It consisted, he said, of plate web girders of 53 m. span and 4 m. high. Each of these girders was welded in the shops and transported by rail to the site in one piece; he believed them to be not only the largest plate web girders ever used in railway practice, but also the largest examples of welding carried out in one piece. The joints in the web plate were made with butt welds without any cover straps; the flanges consisted each of three plates, the longest being 53 m. long, in one piece without a joint. It was connected to the web plate without any space between by means of a double V or X weld. The bridge was completed; extensions of the same type were in hand and would be completed this year.

Mr. A. C. Vivian, who pointed out that bare wire electrode gave a brittle weld as compared with that made with a covered electrode, said that if one could design so that there would be no bending whatever, but pure tension, no doubt the bare wire weld would do; but if it were employed in a steel structure subject to flexure, and therefore bending, there was some danger, because the brittle weld could not distribute the stress over the whole area of the weld and there was liability to local failure. The difference between bare wire and covered electrodes was somewhat similar to the difference between cast iron and mild steel as materials of construction.

Discussing a paper by Mr. Gilbert Roberts on the design and tests of butt-welded joints, he ascertained from the author that the welds described therein were made with the asbestos-covered type of electrode, and said it would be unwise to draw conclusions from the paper unless one knew that. That type produced a large amount of slag covering the deposited metal. He imagined that slightly different results would have been obtained with the gas shell type of electrode, which depended chiefly, for protecting the weld metal against inclusions which would make it brittle, upon surrounding the weld metal with gas, depositing only a light amount of slag to cover the deposition of the metal while white hot; he hoped alternative investigations with the gas shell type of electrode would be made. Whereas one could obtain equally good physical results with both types, the gas shell type, under ordinary circumstances, was very much faster.

Mr. A. C. Hartley, appealing for co-operation in advancing the application of welding, urged that the designer of structures should adopt types of joint which enabled the work to be carried out quickly, that the electrode manufacturer must get used to making larger sizes, and that the welding apparatus manufacturer must develop machines for larger currents. By using larger electrodes, higher ampèrages, and the type of joint that could be handled very quickly, 20 or 30 per cent. of the time could be saved.

Dr. L. Reeve thought the favour with which bare wire welding was held in Germany seemed to be partly responsible for the fact that German working stresses were definitely lower than those allowed by specifications in this country. The German specifications were much more lenient than ours with regard to the bend test. Our B.S.S. 538 insisted on a bend test in a butt-welded joint to an angle of at least 90 deg., but he believed the corresponding German specification accepted a bend angle of only 50 deg. He asked Dr. Strelow, who had referred to reasonably good welds being obtained with bare wire, what type of bare wire he had used; there was one bare wire, containing from 2 to 3 per cent. manganese, which would give a weld of reasonably good ductility—such as 12 to 15 per cent. Apparently there was no distinction in the German specifications between the working stresses for fillet welds as end fillets or side fillets, the working stress being given in both cases as 0·65 of the allowable working stresses in the steel. B.S.S. 538 and corresponding American specifications drew a distinction between end and side fillets, and allowed end fillets to be loaded considerably more highly than side fillets.

Dr. W. H. Hatfield (Brown, Firth Laboratories, Sheffield) defined welding in perfection as "the art of jointing parts of the same metal in such a way that the result is a continuity of homogeneous material of the composition and characteristics of the two parts which are being joined together," and insisted that in the production of reaction vessels for chemical processes, and so on, the standard of the art must be in accord with that definition. Welding should be considered from two points of view—the standard of technology and the cost, and the cost would differ according to the character of the job.

From the technical point of view it must be understood that in welding one was depositing a liquid metal and was liquefying metal in the vicinity of the weld; hence, there was differential freezing, and its consequences, and, without the utmost skill and a good deal of luck, complete solidity and homogeneity from the mechanical point of view could not be achieved.

Dr. Dörnen, replying to the question with regard to the plate web bridge girders of 53 m. span at Rüegen Dam, said the steel used was the German St37; the welds were made with heavily coated electrodes giving 50 per cent. higher strength than was required in ordinary work in Germany. The elongation required on a test length of five times the diameter had to be not less than 25 per cent., thus affording a much greater strength. The working stresses laid down in Germany were given in the paper by Dr. Schaper; the proof stresses for butt welds were 20 per cent. higher than for fillet welds. In the continuation of the bridge referred to, spans up to 65 m. of plate girders, 4 m. high, were being erected.

Mr. Gilbert Roberts (Dorman, Long and Co., Ltd.) suggested that the problem of the residual stresses likely to be set up in welds, chiefly through the thermal disturbances involved, provided the key to the solution of the problems concerning the size of electrode and the most suitable current to be used. For thick butt welds, with electrodes of larger size which produced less slag, forms of preparation might be practicable which would not be possible with the more normal size and type of electrodes. At the same time, if a very large electrode and large current were used for building up a thick butt weld, the greater heat was liable to cause heavy undercut on the sides, which provided a groove in which the slag might be trapped by succeeding runs. In the absence of experimental evidence, he was inclined to think that a large number of small runs produced a more satisfactory result than the use of larger electrodes, higher currents and heavier runs, so far as residual stresses were concerned. The plates in the welded bridge at Newport, Middlesbrough, were of substantial thickness. Most of the web plates were ⅜in. thick and the flange plates 1¼in. and 2in. thick. The fillet welds connecting them were mostly ¼in. deep and in no case more than ⅜in. No distortion occurred during the welding, although no special precautions were taken to do it in any particular order. The residual stress problem seemed to be related to the proportion between the size of the fillets and the size of the work, and he considered that in ordinary structural work, where only small fillets were required, the effect of residual stresses was negligible. In building up for the butt welds it was arranged that the plates being butt welded were free to move at right angles to the butt weld until the weld was complete, *i.e.*, the flange plates were butt welded together where necessary before they were fillet welded to the web. In that case no residual stress over the whole section of the flange plate could occur owing to the butt welding. There remained the residual stresses set up in the weld itself by the cooling of the weld metal in successive runs, and there was no doubt that when a weld was deposited the material in it was stressed up to its yield point by the self-stressing due to cooling. He believed such self-stressing accounted for the higher yield point generally found in weld metal.

There was no reason why the working stresses in a butt weld should not be the same as in the plate; it was generally recognised that the yield point of steel was the true criterion of its strength, and the yield point of the weld metal, and certainly its ultimate strength, was greater than the yield point of the steel. Provided the butt weld was sufficiently strong to develop the yield stress of the plates it joined, he did not think it mattered whether its ultimate strength was 10 or 15 per cent. below the ultimate strength of the plate. In the bridge referred to the butt welds were assumed to be 100 per cent. of the strength of the plate, instead of the 75 per cent. used in Germany and the 85 per cent. in the new British Standard Specification.

Mr. H. J. L. Bruff mentioned some results obtained in repairing and strengthening bridges on the L.N.E.R., where large electrodes would not produce a good fillet weld on all-wrought iron and all-steel bridges. In several tests, welds were made with 4 and 6 gauge electrodes, and with Nos. 8, 10, and 12, and on cutting out the fillets it was found that there was not penetration in the corners. It might be that part of these all-steel bridges had been corroded, and that corrosion between the plates had prevented penetration; but in one case there was definitely moisture behind, which presumably produced steam and so prevented penetration.

Dr. A. B. Kinzel (Union Carbide and Carbon Research Laboratories, Inc., U.S.A.), said that the proponents of electric welding in the United States had almost unanimously agreed that in important engineering structures, where security was a factor and where the flexure or rigidity was such as to impose stresses on the weld, covered electrodes or oxy-acetylene welding should be used. About half the pipe lines in the United States were being welded with covered electrodes and the other half by oxy-acetylene welding. Repairs in railway work were effected very largely by oxy-acetylene welding, and where that was not possible the covered electrode was used. Occasionally the type of repair rendered it absolutely necessary to use bare wire, but it was appreciated that the resultant weld would not be considered serviceable where heavy shock or heavy duty were involved. Pressure vessels were being welded largely with covered electrodes. Some were being manufactured by the oxy-acetylene process, and recently two machines had been put into service to weld automatically by the oxy-acetylene method plate up to 1in. thick at a speed of about 12ft. per hour. Very promising economies were indicated.

Mr. W. Hamilton Martin, M.I.N.A., commented upon the roller water-gas lap-welded drum as being preferred to the fusion welded, and said there were 1200 water-gas welded boiler drums at work. Large water-gas welded steam storage vessels, which were subject to very great and sudden variations of temperature, were satisfactory; the condition of the weld, being rolled, was stronger and more uniform, and the zone on either side of the weld did not contain such heat stresses as in a fusion weld. He did not think the electric weld could yet beat the water-gas weld where difficult stresses had to be met.

Dr. A. McCance mentioned experiments on behalf of shipbuilders in which riveted and welded lap joints were compared. The strength of the riveted joints, under the usual standard conditions of rivet spacing, was of the order of 1½ to 2 tons per inch length of joint; in the case of similar lap joints, with a double fillet weld, with the very worst welding by an unskilled welder, the lowest strength obtained was of the order of 5 tons per inch length, and with ordinary skilled welding the strength was in the neighbourhood of 10 to 12 tons per inch length. So that there was a very wide latitude either in regard to the weld metal or the method of laying it down, and welding still gave a very satisfactory practical alternative to riveting.

Dr. S. F. Dorey pointed out that in welded construction the aim was to produce an article superior to that made as a casting, and suggested that there was still a lot to be desired in regard to the homogeneity of metals used in ordinary construction. He considered that in respect of Class I pressure vessel none of the regulations were too stringent, but it was necessary to grade pressure vessels and to prescribe tests to suit each class. It seemed that it was possible to get quite as good workmanship in a welded as in a forged boiler drum; in certain directions it was possible to get a better vessel. It was difficult to make definite rules for heat treatment. For example, people, such as Messrs. Pfinck's, of Berlin, considered that all drums should be normalised at 900 deg. Cent.; others, such as Messrs. Babcock and Wilcox, considered it satisfactory to heat to a temperature of 560–600 deg. Cent.; others, such as Messrs. Krupp, held that no heat treatment was necessary—and, according to the evidence put forward, each method seemed to be the best. He had seen the results of an elaborate series of tests made by Messrs. Krupp, which were sufficient to satisfy one that without heat treatment, and with the quality of steel they used and the austenitic electrode they adopted, the results might be considered very satisfactory. At the same time,

he believed one could say that with heat treatment at 600 deg. Cent., possibly 90 per cent. of the residual stresses were removed. Again, with heat treatment at 900 deg. Cent., and with the type of electrode used in that case, it was possible to get almost the same type of structure in the deposited metal as in the parent plate.

Undoubtedly the water-gas welded drum was very useful in certain spheres. But it was important to note that Messrs. Pfinck's, of Berlin, who might be regarded as pioneers in the manufacture of water-gas welded drums and had made them for thirty years, had directed attention to the fusion welded drum, for the reason, he was informed, that they considered they could produce a superior article.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE DOUGLAS SOCIAL CREDIT SCHEME.

SIR,—Though reluctant to encroach further on your space, I shall be glad if you will find room for the following comments. Unfortunately, it is impossible to clear up complicated misunderstandings in a few lines.

To deal with the "A+B Theorem," I must first quote Major Douglas himself. He states (pages 21–25, "Credit Power and Democracy"), that purchasing power distributed as payments may be divided into two groups:—

Group A: All payments made to individuals (wages, salaries, and dividends);

Group B: All payments made to other organisations (raw materials, bank charges, &c.).

"Now," says Major Douglas, "the rate of flow of purchasing power to individuals is represented by A, but since all payments go into prices, the rate of flow of prices cannot be less than A+B." From this he deduces that consumers do not in this way receive enough purchasing power (A) to enable them to buy the whole of the product, which is priced at A+B.

"In considering the above arguments," he continues, "let not the reader allow himself to become confused by the fact that B has at some previous time been represented by payment of wages, salaries, and dividends. While this is, of course, true, it is irrelevant; it is the rate of flow which is vital."

Well, let us consider these statements. Take a series of years or other convenient time periods in which the A payments are represented by A, A_1, A_2, &c., and the B payments by B, B_1, B_2, &c. Major Douglas admits that B payments have "at some previous time" represented distributions of purchasing power in the form of wages, salaries, and dividends. For the sake of simplicity let us make the assumption (quite legitimate so far as this discussion is concerned) that "at some previous time" means the previous year or other time period selected in each case. Then we get:—

Years, 1930–1935.

	Total distributions of purchasing power.						
	1930.	1931.	1932.	1933.	1935.	1935.	
	A	A_1	A_2	A_3	A_4	A_5	A_6
B	B_1	B_2	B_3	B_4	B_5	B_6	

This diagram, I think, shows conclusively that, if Major Douglas's own frame of reference is accepted, then the rate of flow of purchasing power to the public is not A, as he asserts, but A+B; since there is nothing to distinguish A_1+B_2, &c., from A+B so far as continuous flow of purchasing power is concerned. Thus the "A+B Theorem" breaks down on Major Douglas's own statements. If this demonstration is not clear, I shall be happy to discuss the matter further until your patience, Mr. Editor, and that of your readers, is completely exhausted.

To turn to other points. Mr. Bardsley tells us that "with one single exception, Major Douglas has never opposed any individual or association connected with monetary reform." But this has no bearing on my remarks, which he quotes, about Social Credit enthusiasts in general (*not* Major Douglas in particular), about contempt (*not* active opposition), and about views and ideas (*not* individuals and associations). I would not have referred to this had it not seemed so typical an example of the baffling inconsequence which is the despair of many who attempt to follow Douglas Social Credit literature.

Mr. C. W. Ryden endeavours to create prejudice with facetious remarks (about "grotesque figures," &c.), a common but not very helpful trick of discussion. He then invites us to imagine a philosopher advising the engineers who planned the grid system of electrical distribution "to cultivate a change of heart and study psychology as an aid to the solution of their technical difficulties!" This, again, has no bearing on my remarks, which advocated a study of psychology as an aid to the solution of moral—*i.e., psychological*—difficulties.

In 1910 the late Dr. Ferranti, in his Presidential Address to the Institution of Electrical Engineers, recommended a change from the muddle which then existed to a nation-wide scientifically planned system of producing and distributing electricity. Years passed, and nothing effective was done. If, at that time, some ardent reformer had suggested that the difficulties to be contended with were mainly technical, and that the universal application of a simple formula would overcome these difficulties, Ferranti would undoubtedly have been justified in retorting that, on the contrary, what was most required was a change of mind and heart, and in advising that reformer to study psychology. As a matter of fact, nothing effective was done until a sufficiently widespread change of mind and heart overcame resistance and made effective action possible. This change was due in part to a gradual decay of faith in old economic doctrines (*e.g., laissez-faire*), and an increasing faith in new economic ideals, such as rationalisation and scientific planning on a national scale. The impact of a world war greatly facilitated the psychological reorientation which this implies.

One of the plainest lessons of history is that effective action has constantly to wait on psychological change for long after the technical solution of a problem has been found. Here is an example from an old copy of the *Manchester Guardian*: "For a long time now men have known that the emission of smoke from factory chimneys, and more particularly from multitudes of domestic chimneys, is a selfish anti-social act. We *know* that it is immensely costly to the community and inimical to the health of the people; that disease and darkness go together; that coal is a treasure-house of valuable products which is wastefully rifled by the ordinary means of burning coal. We *know* these things, and yet practical action is met by apathy, if not opposition."

The truth is, of course, that muddle and chaos in the so-called civilised world are merely symptoms of mental and moral disharmony. The disease itself and its cure must be sought through the tortuous, labyrinthine ways in the hearts and minds of men.

But the mental and spiritual resistance to a scientific organisation of wealth distribution is almost out of comparison greater than that which delayed the coming of the grid system of electricity distribution, and still delays smoke abatement, which has now been advocated for nearly 300 years. Proposals which involve thorough-going changes in financial procedure and the distribution of purchasing power arouse deep-seated instincts, emotions, passions, prejudices. At every turn social and monetary reformers who venture to attack the idols of the market-place encounter ignorance, suspicion, intolerance, ridicule, fear, obduracy, misrepresentation, stupidity, egotism, selfishness. It may be that a simple formula or technical mechanism can be devised that will facilitate the overcoming of these formidable obstacles. That, however, is not my view. Understanding must precede action. To understand machines you need a knowledge of engineering; to understand those far more complex mechanisms, human beings, you need a knowledge of "human engineering"—*i.e.*, psychology. But it may be said, we cannot take time to understand, for the house is burning. That, of course, was the attitude of the man who rushed and struggled and made a panic in a theatre fire, with the result that he and many others were trampled upon and burned to death.

HUGH P. VOWLES.

London, S.W.19. May 11th.

SOCIAL CREDIT.

SIR,—I am in entire agreement with Mr. Hugh P. Vowles as to the recognition due to Kitson and Soddy for the inception of social credit principles. I have long felt that it was doing less than justice to the prime authors labelling the movement "Douglas Social Credit." On the other hand, seeing the two systems are quite distinct in principle, how is one to distinguish between them except by the personal label?

Mr. Vowles treats the matter as one for academic discussion. I suggest that forty years, or even twenty, is ample time for such exhaustive scrutiny, and that no useful purpose can be served by prolonging the process at this stage.

If he had been a victim of the present economic impasse, by which I mean if he had suffered repeated retrenchment on financial grounds; if as a salaried assistant he had repeatedly found himself out of employment, and having family responsibilities had found work unobtainable on any terms whatever, I suggest that Mr. Vowles would conclude that there was a certain urgency for the reform which is the subject of these letters.

Surely it must be agreed that the means are of less importance than the end; we have ample evidence of the supreme need for an immediate monetary reform. I will mention only a few authorities whose recent pronouncements attest to this:—Mr. Harold Butler, International Labour Office; Sir Frederick Leith Ross, the Federation of British Industries Quarterly Report; Capt. Evan Wallace, Lord Allen of Hurlwood, Sir Norman Angell, C. Ploydell Bouverie, and the several contributors to "The Frustration of Science." But my point is that Douglas alone has developed an electoral method by which results can be obtained with anything like the rapidity that is so generally admitted to be necessary.

I appeal, therefore, to Mr. Vowles, and to all readers of THE ENGINEER, to sink their personal predilections and to close their ranks in support of the electoral campaign for the National Dividend.

As to Mr. Eric Gill's fear of leisure for the masses, I suggest that it is no business of his or mine the use to which they put their leisure; there are such things as hobbies and sports; there is research and invention; there is education, culture, and travel; but even although the masses did nothing beyond spending their newly-found purchasing power, they would be enabling the wheels of industry once again to turn, raising the general standard of living, and thereby promoting the national prosperity.

Lymington, May 8th. NEW BRITON.

DEMECHANISATION.

SIR,—Does machinery produce unemployment? The original idea of labour-saving devices must have been to mitigate this curse. In a purely agricultural community in which preparing the soil and harvesting takes six months of the year, all labour must be without productive employment for six months annually. Take three farmers, A, B, and C, each requiring the labour of ten men for six months. Obviously, the labour must be kept alive between seasons; a "dole" is a necessity. A keeps ten men doing nothing, and feeding them so that he will get their labour when he wants it. B only employs labour productively; as he conserves his resources he is able to tempt men away from A by offering better conditions. C keeps five men employed all the year round; in the idle seasons he employs them making labour-saving implements, so that when the busy season comes round he will only need five men to do ten men's work. B has no advantage over C in the labour market, as during the year they both employ the same amount of help. If the problem rests with A and B, slavery or serfdom is an economic necessity, as it is with draft animals. With C free wage labour is not only possible; it is desirable. C has found a way of "potting" labour when it is plentiful to use when it is scarce.

In ancient Egypt it must have been an advantage to the farmer to have to supply labour and its food to the Pharaoh between seasons, so that he could build his pyramids. These were a kind of public works enterprise to employ the unemployed in those days. The system was intolerable to the Israelites, who, being stock-raisers and traders, had no seasonal unemployment problem to solve.

That is the case for machinery in a nutshell. It is a "labour accumulator," and is to labour what electrical and hydraulic accumulators are to a power plant.

In the case of Farmer C he only had to wait six months for the return of his expenditure. In a more complex economic system, the time will be longer and the capital involved proportionately greater. If certain machines take ten years to build and ten years to wear out, ten years' wages will have to be expended before there is any return. Each year the machines will give out the work that was put into them ten years previously. Under any credit scheme the amount of capital that can be raised (or "created") will depend on the lender's power of foresight, and will be some function of the surplus labour that is available for employment. If all labour was employed under ideal conditions, no further capital could be "created" by any scheme.

Machines are "potted" labour, but what has to be conserved has to be foreseen, as the range of the machines is more limited than that of the original labour that produced them.

A skilled workman is like a machine, as he expends unproductive labour acquiring habits which he hopes will meet a special demand during later days.

By machines, labour can be "potted" when, or where, it is plentiful and expended when, or where, it is scarce.

The moral of all this is that machines did not introduce cyclical unemployment or the "dole." It is because these things existed first that men turned their minds to producing labour conserving devices, and thus gained the power to mitigate the evil, and incidentally the power to make it ten times worse.

J. N. WILLIAMS, M.I. Mar. E.

May 11th.

A NICKEL ALLOY MANUFACTURERS' CENTENARY.

AN interesting event took place on Tuesday, May 14th, when a special visit was paid to the Wiggin-street Works of Henry Wiggin and Co., Ltd., of Birmingham, in order to commemorate the centenary of the firm. The history of the firm can be traced from its founders, Charles Askin and Brooke Evans, who began business in a modest way at George-parade, Birmingham, as nickel refiners and German silver manufacturers, up to the more recent developments which have made the works of Henry Wiggin and Co., Ltd., one of the largest and best equipped rolling mills in Europe for nickel alloys. Going through the works which have recently been reorganised, a good deal of new plant and a great variety of work was to be seen. The latter included the production of finished and semi-finished manufactures in nickel and its alloys, of which the production of nickel anodes, electrical resistance alloys, and cutlery blanks were among the most important. The resistance materials manufactured by the firm include the nickel-chromium alloy Brightray, the nickel-chromium-iron alloy Glowray, and the nickel-iron alloy Dullray; also the copper-nickel alloy Ferry. Interest was shown in the testing side of the business and the technical service department which has been set up and is maintained to give information and free advice on the uses and application of nickel and its alloys.

The British Industries Fair at Birmingham.

No. I.

INTRODUCTION.

IN a Supplement which accompanies this issue, we give some account of the numerous exhibits to be seen at the British Industries Fair, Engineering and Hardware Section, which opens at Castle Bromwich, Birmingham, next Monday, May 20th. On these present pages we continue our descriptions, and we intend with a following issue to publish a second Supplement dealing with the Fair.

JAMES GORDON AND CO., LTD.

A variety of boiler-house equipment will be shown by James Gordon and Co., Ltd., of Regent House, Kingsway, London, W.C.2, most of which is intended for the automatic control of working conditions, so

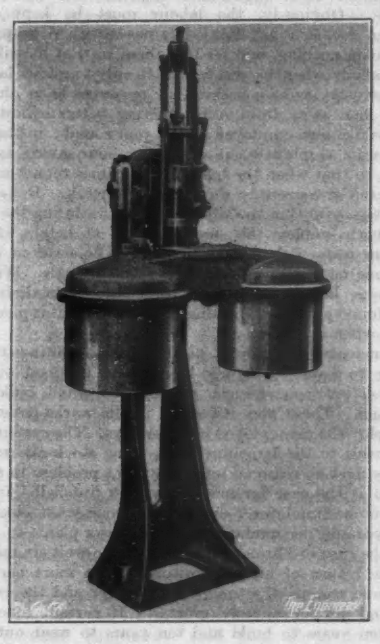


FIG. 1—FLOAT REGULATOR—GORDON

that the boilers may be worked in the most efficient manner regardless of the momentary load or demand for steam. The most novel among these pieces of apparatus are the float regulator illustrated by Figs. 1 and 2, and the water level gauge shown in Fig. 3.

The Hagan float regulator—Figs. 1 and 2—is for such purposes as the control of flue dampers to

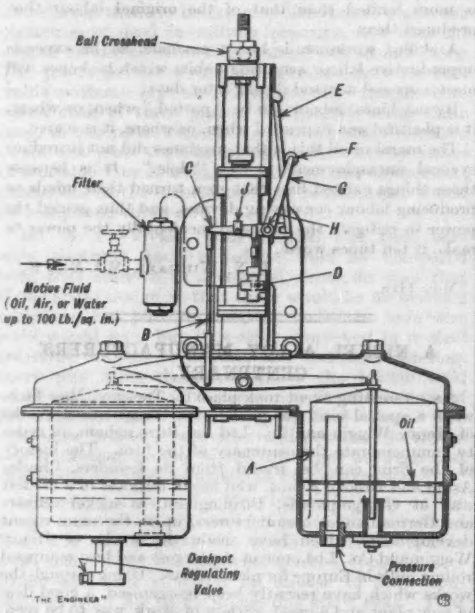


FIG. 2—CONSTRUCTION OF FLOAT REGULATOR—GORDON

suit the draught. The damper control is effected by a float regulator and a receiving regulator. This float regulator measures the draught in the combustion chamber, and adjusts the forced draught damper through the receiving regulator to maintain a constant suction. With a small increase in load the vanes of the induced draught fan open up, but the forced draught fan speed is not yet increased, so its damper will be opened up to supply the required increase in air supply; later, when the F.D. fan speed is increased, the damper will close as far as may be necessary to give the correct air flow.

The float regulator combines stability of operation with sensitiveness to pressure, flow, or draught control. Spun aluminium floats are suspended from an aluminium beam supported at the centre on a combination of knife edge and jeweller's point, which has no lost motion and practically no friction. For constant draught or pressure, one float is connected with the furnace, gas main, &c., and the other is open to atmosphere. An increase in the pressure causes the corresponding float to move upwards, thereby increasing the effective weight of the float dependent upon the decreased submergence of the cylindrical wall of the float. At the same time the effective weight of the atmospheric float is decreased in proportion to its increased submergence. These changes of weight combine to oppose the change of the condition under control and bring the floats to rest after a movement which is proportional to the change. For flow control, connections are made from an orifice to the two floats. A modified design of regulator is used for regulating the flow of one of two media in relation to the other.

With a downward movement of the float A the connecting-rod B moves upwards, and through the lever C moves the pilot valve D downwards to admit motive fluid to the bottom of the operating cylinder. The crosshead moves upwards carrying with it the compensator E, which causes the roller F to move to the right. This roller is carried on the bell crank G pivoted at H and supporting the lever C at the pivot point J. When the roller F moves to the right, the pivot J moves upwards and raises the pilot valve to its closed position, which stops the regulator after a movement dependent upon the extent of float movement. The depth of the floats depends on maximum pressure or suction which may occur, while the size of the power cylinder is chosen with respect to power required to operate a damper, &c. It is claimed that this regulator is sensitive to variations of pressure as small as 0·002in. w.g.

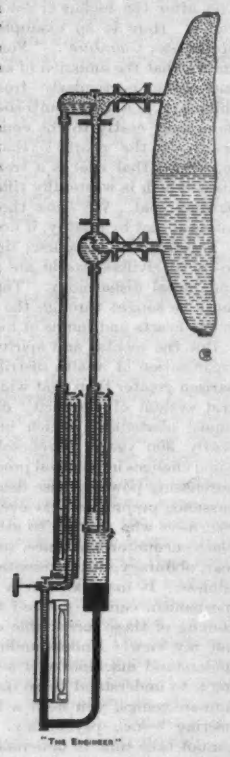


FIG. 3—WATER LEVEL GAUGE—GORDON

The water level gauge—see Fig. 3—is intended for boilers which are so tall that it is not possible to read the ordinary gauge accurately from the floor level. It virtually consists of a long U tube, the lower part of which is filled with a coloured liquid, while the upper ends of the limbs are connected with the branches for the ordinary water gauge. The liquid is usually coloured red, and is of a greater density than water, while it will not dissolve in water. It is contained in a tube illuminated by a strip-light behind, which may be arranged at any convenient level. At the top of the U tube, on the steam side, there is a chamber which acts as a condenser and keeps the apparatus full of the water of condensation. There are also two traps in the limbs for collecting any dirt. Appropriate clean-out plugs and cut-off valves are provided where necessary. It will be appreciated that the gauge glass, while it is subjected to the boiler pressure, remains cool and, consequently, is not very liable to breakage.

COCHRAN AND CO., ANNAN, LTD.

On the stand of Cochran and Co., Annan, Ltd., will be seen in operation one of the firm's 7ft. by 15ft. coal-fired boilers. The boiler has been in use at the Exhibition building for a number of years on loan from the makers, and provides steam and hot water to the kitchens and heating system. This year the date of the Fair obviates the necessity for steam heating, but the kitchen and general services of the Fair will provide a load sufficient to keep this exhibit steaming. In addition, Cochran and Co. will demonstrate their new Cochran-Kirke Sinuflo gas-fired boiler, several boilers on this principle having already been installed in schools, cinemas, and institutions in various parts of the country. When town gas is used as a fuel, the thermal efficiency of the boiler becomes of great importance. The Cochran-Kirke Sinuflo principle is claimed to accelerate the transmission of heat by 150 per cent. The principle is to bend the fire tubes in a series of alternate sinusoidal curves, thus obtaining a "wavy" tube, and in this way achieving the effect of "baffling" the gas flow without its complications. By this method the length of the fire tube in the same size of boiler has been

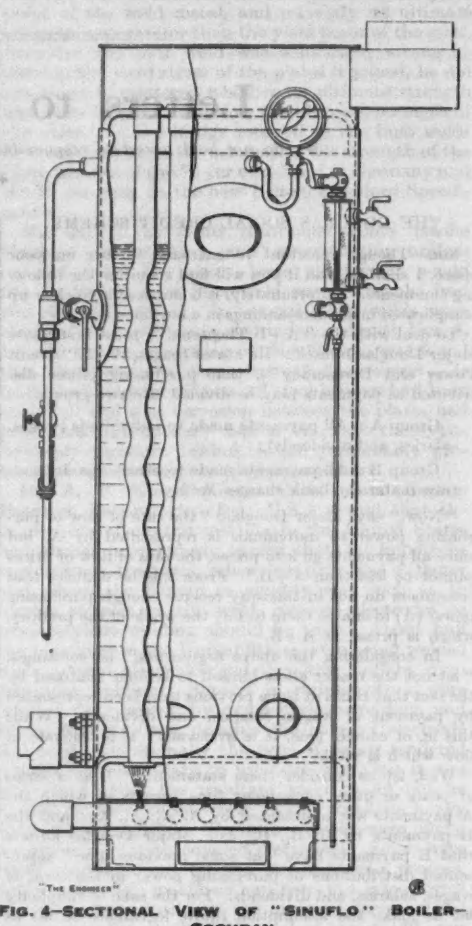


FIG. 4—SECTIONAL VIEW OF "SINUFLO" BOILER—COCHRAN

increased by 2½ times, so that full use of the hot gases is made. No difficulty arises in the cleaning of these tubes, as either a short steel brush or a long fibre brush can be passed up the tubes. The boiler is completely automatic in action, feed water, gas supply, and steam pressure being interconnected so that a failure of the water supply or an excess of steam pressure cuts off the gas supply. In addition,

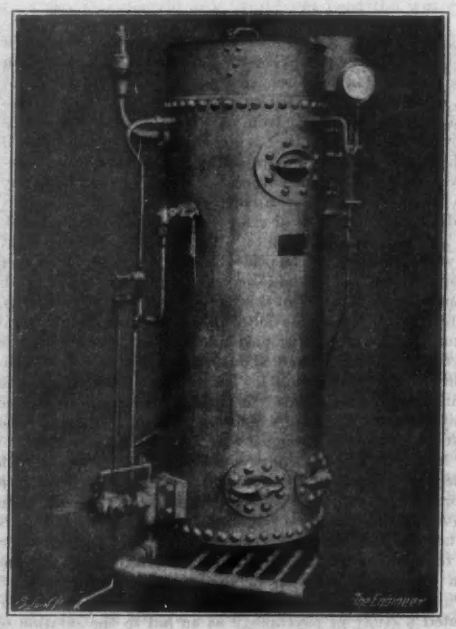


FIG. 5—"SINUFLO" GAS-FIRED BOILER—COCHRAN

an automatic draught regulator is available if required, so that extra rapid steaming can be obtained. According to the makers, the boiler, when fully lagged, gives a thermal efficiency on the net calorific value of the gas of 85 per cent. An injector is fitted as standard, though either a steam-operated or an electric water pump is available as an alternative, the makers recommending the electric pump as the most economical method of feeding the boiler. A

view of this boiler and a section showing the Sinuflo type tubes are shown in Figs. 4 and 5.

RUBERY, OWEN AND CO.

A variety of pressed steel articles will be exhibited by Rubery, Owen and Co., of Darlaston, Staffordshire. These include a series of pressed steel pulleys, similar to those illustrated in Fig. 6, and designed with a view to the facility of their erection even in the most awkward positions. Thus all bolts are locked in position to prevent their rotation, so that tightening the nuts becomes a job requiring only one hand,

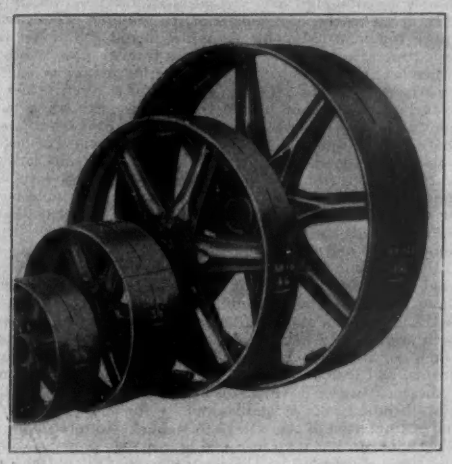


FIG. 6—PRESSED STEEL PULLEYS—RUBERY, OWEN

which is an added safety precaution when men have to work on high shafting. Before leaving the works all these wheels are carefully balanced. There can be little doubt that this action results in a considerable saving of power costs in large shops where a number of such wheels are in use. The firm also produces a wide range of pressings for the automobile, industry. Chassis frames, drip pans, dust shields and covers will be shown, together with another product, the "Magna" wire wheel. Rubery, Owen and Co. will also display a series of cupboards, bins, and lockers for the storage of small parts and tools and also a number of filing cabinets and other articles of office furniture. All of these pieces enable a large amount of storage space to occupy a small amount of room without impeding the accessibility of their contents. A good selection of the firm's productions in "Staybrite" steel, such as nuts, bolts, pins, and small spindles, is to be on view and various illustrations of structural steel constructions undertaken by the firm.

FRY'S (LONDON), LTD.

An interesting display of small tools and mechanic's equipment is to be shown by Fry's (London), Ltd., of King-street, London, E.1. We illustrate in Fig. 7

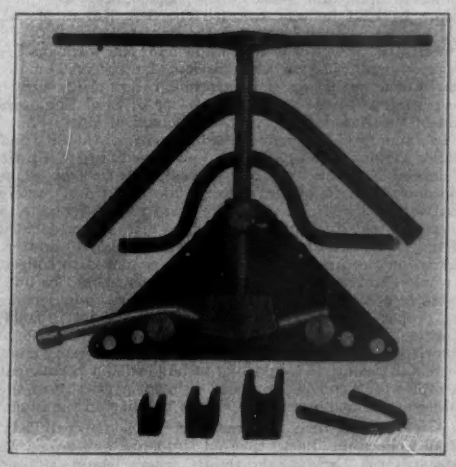


FIG. 7—THE "APEX" BENDING MACHINE—FRY'S

a useful example. This is a small bending machine—the Apex—used for pipes, rods, &c. It is made in three sizes of bed-plate, and will take pipes of diameters from ¼in. to 2in. The bed-plate is a steel casting fitted with a solid steel nut, through which passes a square-threaded screw having malleable iron handles attached. Cast iron formers are used to ensure a correct radius for the bend. These are supplied in different diameters to fit the various pipe sizes. The weights of the bending machines are given as 45 lb., 66 lb., and 120 lb. for the three sizes. Such machines will, it is claimed, bend galvanised pipes or rods without damaging the galvanising. Another useful tool to be shown is the Enox ring saw, which, in its new form, has the band saw mounted on the outside of the aluminium body and held in tension by two screws. This new mounting is claimed to prevent slip in use. Various sizes are available to saw standard pipe diameters. Both from the point of view of time saved on the job and that of finish, this tool has possibilities and is certainly an improvement on the old method of "drilling out" a hole in a tank or other sheet metal construction.

MODERN WOODWORKING MACHINES, LTD.

Small woodworking machines for use on the bench will be exhibited by Modern Woodworking Machines, Ltd., of Leicester. We illustrate one of these in Fig. 8. It is a compact vertical-spindle moulder. Its overall dimensions are 27in. by 16in. by 18in., and space has not been wasted in this machine. The table, which is 14in. high, has a diameter of 16in. The motor, which is vertically mounted, has two speeds, giving, at the spindle, 3500 and 6000 r.p.m. and it works on the lighting circuit as it only develops ½ h.p. The spindle is slotted for a single cutter, but the makers also supply cutter collars for this machine. The spring-clamping arrangement for holding the work down on the table is most

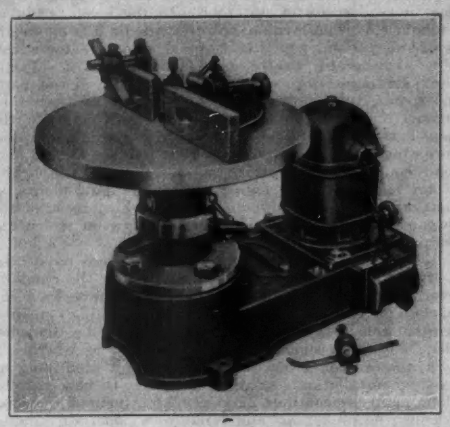


FIG. 8—SMALL VERTICAL SPINDLE MOULDER —MODERN WOODWORKING

practical, as it involves no tightening or clamping and therefore takes no time to adjust, while the cutters are guarded in a satisfactory manner from the operator's fingers. Another machine to be shown by Modern Woodworking Machines, Ltd., is a bench band saw. This is also a two-speed machine and is capable of handling non-ferrous metals as well as wood. The saw wheels are 14in. diameter and are effectively guarded. The table is ample in size and can be canted to any suitable angle, and the machine is most compact.

FOSTER INSTRUMENT COMPANY.

A display of automatic temperature-control equipment, as used in conjunction with heat treatment furnaces, will be seen on the stand of the Foster Instrument Company, of Letchworth. A new type of controller, Fig. 9, known as the "Flexipush," is of the indicating type, and is suitable for use with oil, gas, or electrically heated furnaces. The main control device consists of a large sealed mercury tube switch, which is tipped to the requisite angle by Bowden transmissions, the pointer of the instrument

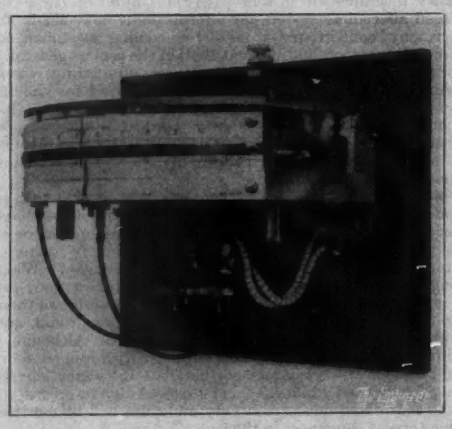


FIG. 9—THE "FLEXIPUSH" CONTROLLER—FOSTER

being depressed periodically by motor-driven depression mechanism. By the use of the maker's patented "Resilia" mounting system, the indicating movement is relieved of all stresses. The complete absence of exposed contacts, delicate electro-magnetic relays, and complicated stator mechanism, is claimed to be an advantage of no small importance.

THE CLARMAC ENGINEERING COMPANY, LTD.

The heating of tar for the manufacture of tarmacadam and for other purposes is a process which requires considerable accuracy, since unequal heating results either in unequal liquefication of the tar or else to boiling over with its wastage and fire risk. The Clarmac Engineering Company, of Port Dundas, Glasgow, will be exhibiting a patent electrically heated tar and bitumen boiler, a pair of which are illustrated in Fig. 10. By utilising electricity as a heating medium, the wastage arising from unequal heating is claimed to be overcome, and with it the fire risk owing to boiling over. This boiler is claimed to be the first to use electricity for the purpose, and already, we understand, several are in use in different quarries, &c. The economy of electricity as a heating medium for large tar boilers is claimed to be high, especially in view of the constant temperature which can be maintained when large quantities of material have to be kept fluid, while the elimination of fire risk

FIG. 10—TAR AND BITUMEN BOILERS—CLARMAC

claimed should certainly appeal to those who wish to use tar, especially in constricted areas or inside a works.

DOMINION MACHINERY COMPANY, LTD.

The Dominion Machinery Company, Ltd., of Hipperholme, Halifax, will be showing under power a range of wood-working machinery. The Super-Elliot Woodworker, in its improved form, is to be on demonstration, as well as the new Elliot woodworker. The latter is a semi-portable machine which can be taken to the job and used for cutting rafters, compound angles, stair strings, tenons, ripping, planing, rebating, chamfering, moulding, cross-cutting, ploughing, grooving, boring, &c. It is a smaller edition of the "Super" machine. The Dominion surfacer and thicknesser will appear as a power machine fitted with moulded sections to the

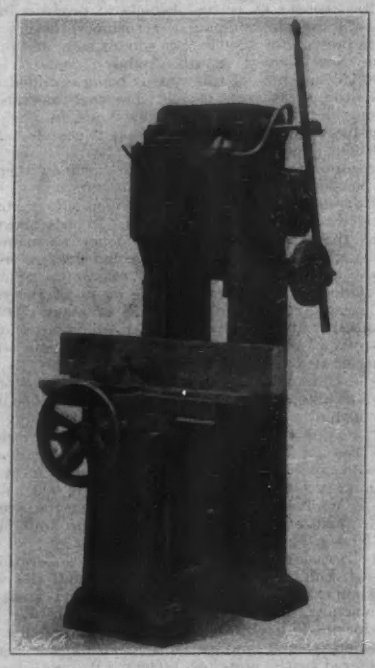


FIG. 11—MOTORISED HOLLOW CHISELER—DOMINION

cutter block and a three-speed gear-box to the feed. It is driven by a single motor, and is said to give 4000 r.p.m. on the block. Power to the block is transmitted by endless multiple vee ropes, and to the feed mechanism by three-speed gear-box and roller chain. On a new motorised hollow chiseler a centralised blower has been fitted over the chisel, with the result that the setting out marks on the timber are kept clear of chippings. We illustrate this machine in Fig. 11. Stop bars available for the firm's mortisers also increase the rapidity with which repetition work can be carried out on these machines by eliminating "marking off" on all the pieces and by superseding the human liability to error. The firm's No. 2 heavy-duty high-speed moulder will be running on the stand. This machine is fitted with a two-speed motor to give 3000 or 6000 r.p.m. on the spindle. The belt is fitted

with a screw belt-tensioning device, and as the spindle is raised or lowered without lifting the motor there is a big difference in the effort required. The table of the machine rotates so that cross slots in the table are avoided. A cross-cutting and trenching machine, as well as a band saw and a sanding machine, are under power on this stand.

LEY'S MALLEABLE CASTINGS COMPANY, LTD.

As might naturally be expected, there are to be seen on the stand taken by Ley's Malleable Castings Company, Ltd., of Derby, a number of typical castings, many of them machined, in the "Black Heart" malleable iron, for which this firm is well known. It is claimed by the firm that as a result of strict and accurate control of ingredients and manufacture, the properties of the material are considerably in advance of British Standard Specifications. A tensile strength of 24 tons per square inch, an elongation of 18 per cent., and a cold bend test of 180 deg., are figures consistently attained. The castings exhibited are designed to indicate the wide range of purposes for which the material is suitable. During the past year the firm has introduced a new metal—"Lepaz"—in the form of heat-treated alloy castings with a high tensile strength and ductility, fine machining qualities, and an unusually high resistance to abrasion. It is especially suited for use in brake drums and shoes, clutch drums, and plate chain units, elevator buckets, chassis brackets, and other similar parts subjected to friction and abrasion. Castings illustrating typical applications are exhibited.

(To be continued.)

Power Station Progress.

A REVIEW of power station progress by Mr. I. V. Robinson appearing in the *Journal* of the Institution of Electrical Engineers, is based largely on visits paid within the last eighteen months to many stations during a tour round the world. Since the last review by Mr. Robinson, published in 1932, the economic depression has been the dominating feature in all industrialised countries. Owing to the reduced load in the countries visited, extensions to plant were not being seriously considered, but engineers were found to be giving attention to the perfecting of details and to future changes in development. There has been no general demand for generating units of great capacity. Even in America there was no increase in size beyond the three-axis, 208,000 kW set at Chicago. On the Continent the position is more or less the same as in the United States. Some manufacturers report that they would be prepared to construct turbines up to a capacity of 250,000 kW at 1500 or 1800 r.p.m. if they were called for, but transport difficulties appear to be an obstacle to progress in that direction. Steeple compounded turbines, designed for a steam pressure of 1200 lb. per square inch, are running well in New Jersey (South Amboy), and a second 110,000 kW machine of this type is being installed in the Ford motor works, but the fact that such machines are not being adopted in cities like New York, in which land is valuable, leads to the conclusion that steeple turbines are without hope of prosperity.

As regards small and medium-size turbines, there has been considerable development in combined turbo-generator sets, *i.e.*, machines in which the turbine is mounted directly upon the condenser. In large generating stations there appears to be a tendency to mount the auxiliary alternator on the main turbine shaft in order to generate the auxiliary power at maximum efficiency. To provide starting current in the event of the station being isolated and standing, a unit of about 2500 kW is installed. Another use for the medium-sized turbine is that of making it serve as a reducing valve in stations working at two steam pressures.

In the United Kingdom and in Germany the popular maximum pressure is still 600 lb., or perhaps 650 lb. per square inch at a temperature of 800–850 deg. Fah. These conditions apply to sets of 30,000 kW and upwards, but in the case of 20,000 kW units the pressure does not generally exceed 400 lb. per square inch. A pressure of 600 lb. is, however, being used on a 15,000 kW. set. There is no hard-and-fast rule governing the pressure. For the smaller sets the upper temperature limit may be only 750 deg. Fah.

The British-made Detroit machine, operating at 1000 deg. Fah., is running satisfactorily, but the control of the superheaters is reported to demand great care. This machine, which only develops 10,000 kW, is too small for modern power stations, and it remains to be seen whether new, and perhaps greater, difficulties are encountered with units of 50,000 kW and upwards. One manufacturer is reported to have stated that he is prepared to offer reasonably sized units working at 1100 deg. Fah., and that he is considering the question of exceeding that temperature. It is suggested that owing to the smaller dimensions, 3000 r.p.m. or 3600 r.p.m. machines lend themselves more readily to 1000 deg. Fah. than lower speed sets. Another British-made machine of 24,000 kW for Russia is designed for 1763 lb. per square inch, and a temperature of 932 deg. Fah., whilst a 36,000 kW, 1700 lb. per square inch set has now been running satisfetorily in Czechoslovakia for a considerable time. During the year ending February 27th, 1934, it was in service 7987 hours and generated nearly 70,000,000 units.

With regard to reheating, engineers are reported to hold practically the same opinions as they did three years ago, when the last report on power station progress was published. With 650 lb. per square inch and 850 deg. Fah., Mr. Robinson explains, reheating is not needed, and as the plant efficiency is not greatly improved by employing higher pressures and temperatures with reheating, many engineers prefer to remain for the time being, at any rate, on the lower operating level. In endeavouring to avoid reheating great efforts are being made to eliminate moisture in the steam at the tapping points, and in some cases special scoops have been fitted at other points in the expansion to catch and remove moisture. Whereas three years ago it was difficult to get any expression of opinion as to the effectiveness of these devices, one maker now quotes actual figures, but does not claim that more than 25 per cent. out of the moisture in the steam is removed.

In referring to the three 50,000 kW Durston sets, working at 600 lb. per square inch, 800 deg. Fah., and reheating at 120 lb. per square inch to 800 deg. Fah., Mr. Robinson points out that these conditions do not necessarily involve reheating, and in this respect the installation is probably something of a pioneer. These conditions represent a considerable advance over those of the earlier installation at Barking, where the initial conditions are only 350 lb. per square inch, 700 deg. Fah., and reheating to 700 deg. Reheating, the report explains, involves greater capital costs, and during recent years they have been scrutinised very carefully.

No great change is reported in regard to feed heating. For the central station unit of 20,000 kW and upwards, the final discharge temperature is sometimes as high as 360 deg. Fah., but the number of feed heating stages does not generally exceed four. In the new station at Trebovice, Czechoslovakia, however, the final temperature is 424 deg. Fah., which is attained in only three stages plus a de-aerator heater, in which there is a 50 deg. rise. Evaporators to supply the make-up feed water are incorporated in most of the large plants. They take steam from one tapping and discharge vapour to the next lower pressure heater, thus working over a temperature range of 50 deg. to 60 deg. Fah. To provide for low-load conditions, the steam supply for the evaporator is not taken from the higher pressure tapping points, so that when the load and pressures are low, most of the heating may be done in the stages between which the evaporator is situated.

During the past two or three years there have been many serious fires which have occurred as the result of overheating of lubricating oil. Oil pipes have been run in close proximity to pipes carrying steam at high pressure without consideration of the fire risk involved. Remedies that have been suggested vary according to whether it is a question of a new installation or of modifying an existing installation to reduce the risk. In new installations many precautions may be taken, including that of placing the oil pumps and tanks in a separate building from that containing the turbine; running oil pipes from the pump to the lubricating system and to the governor system separately, so that they may be closed remote from the turbine; running these oil service pipes in outer drain pipes so that no leakage can occur in the neighbourhood of hot parts; the substitution of extra-heavy-gauge fittings for the standard fittings; the use of oil pipes of a very heavy gauge and with welded joints, and special arrangements for preventing oil pipes vibrating. Where it is impossible in the case of existing installations to separate steam and oil pipes entirely, it is recommended that the steam pipe insulation should be provided with metallic covers so that oil cannot saturate the insulation.

Under the heading of alternators, Mr. Robinson states that the American 160,000-kW single-axis unit operating at 1500 r.p.m. remains the largest. In Great Britain a unit of 100,000-kW is being erected and it will be the largest machine outside the United States. Many engineers remain unconvinced of the practical advantages of such units as compared with 50,000 kW sets running at the same speed, *i.e.*, 1500 r.p.m. One builder states that an 80,000-kW alternator running at 3000 r.p.m. and having aluminium rotor windings would present no constructional difficulties, whilst another is prepared to build a machine of the same capacity and speed without aluminium rotor coils. Incidentally, a 3000 r.p.m. unit of 80,000 kVA is in operation at Antwerp.

As is well known, marked progress has been made in the construction of 33–36-kV alternators in this country, but little has been done in this connection elsewhere, although 22-kV machines are in service in the United States. The closed air cooling system for alternators is now usual. In Germany condensate is used for cooling as much as circulating water, but in Great Britain the coolers generally form a shunt across the condenser circulating water system. While hydrogen has been employed for cooling synchronous condensers operating out of doors, this method of cooling has not been applied to alternators, although if outdoor generating stations materialise the use of hydrogen as a cooling medium for alternators is within the range of possibility.

Since the previous report there has been little change in condenser practice. As multi-exhaust turbines have become increasingly popular there has been no increase in the size of the individual shell. Owing to material limitations the vacuum has not varied greatly. While single-pass condensers are favoured in America, they are not popular elsewhere. The conditions favourable to them are an ample supply of water, a low pumping head, and sufficient room for a long tube condenser. Although a number of condensers are now supplied with hinged doors and divided water circuits, so that half the water surface may be cleaned while the condenser remains in operation, it is considered doubtful if very great use will be made of this type of condenser in the future.

With the advance in boiler pressures it was anticipated that the usual type of water-tube boiler would have to give place to new designs, but in the great majority of high-pressure stations the usual water-tube boiler with natural circulation is used. It has done so well that many American engineers are endeavouring to install one boiler per turbine, notwithstanding that the kW capacity of the latter may be expressed in six figures. Despite the excellent performance of the old type of boiler, however, the newer "evaporative" types, such as the Benson (not strictly evaporative), the Loeffler, and the Velox have made some headway.

The use of water walls has increased considerably and they have been applied to boilers with an evaporative capacity as low as 30,000 lb. per hour. The wall system is now generally tied in with the main boiler and does not, as originally, form part of a separate circuit leading direct to the steam drums. With the increased use of water walls the fuel consumption per square foot of grate surface has much increased, and at the same time the stokers are attaining formidable dimensions. They are now made with widths up to 30–33ft. and 20–22ft. long. Since the previous report there has been little change regarding the position of pulverised fuel. On account of the dust trouble, solid fuel is often preferred in towns; but, as is well known, pulverised fuel installations are claimed to offer considerable advantage from the point of view of flexibility. With steam temperatures of 850 deg. to 930 deg. Fah., and in one case 1000 deg. Fah. at the turbine, the temperature at the boilers is approaching a value at which the performance of the material becomes a matter of utmost importance. With lower steam temperatures a fluctuation of perhaps 100 deg. Fah. in the steam temperature at the boiler was permissible, but such a variation cannot be accepted now. Consideration has therefore been given to the best means of maintaining a constant upper temperature. One firm has introduced a device called an attemperator, which is a tubular vessel fitted either between two superheaters in series or after a single superheater, and in which the tubes are covered by feed water. In the event of the temperature exceeding the limit a throttle valve is closed by thermostatic action and the steam is diverted through this chamber. The feed water cools the steam to the predetermined temperature and the heat is returned to the boiler drums in the form of steam. In the Loeffler boiler the same result is obtained by controlling the speed of the steam pump, more steam being passed through the superheaters to reduce the temperature and *vice versâ*.

Up to about five years ago riveted boiler drums were used for pressures of about 700 lb. per square inch, but there was always some doubt as to the effective closing of the long rivets required. Since then forged drums have been largely used, but they are naturally very expensive. Much consideration has been given to the use of welded drums, and it is now possible to weld satisfactorily up to 4¼in. thickness. The thickness is only really limited by the plate bending rolls available, and by the X-ray plant for the examination of the welds. A welded steam receiver of large capacity has been installed in a British power station and there appears to be no reason why they should not be more generally used.

Memorial to the Late Dr. W. C. Unwin.

AT a meeting of friends and past students of the late Dr. W. C. Unwin, held at the Institution of Civil Engineers on February 13th last, it was resolved unanimously to invite subscriptions to establish a fund to be utilised for commemorating the very valuable services which he rendered to engineering science, both by way of research and published writings, and the leading part which he took in the evolution of the scientific training of engineers. He will be remembered as much for his services on the many large engineering problems on which he was consulted as for his educational work. He was in his day a leading authority in many branches of engineering, including hydraulics, pneumatics, gas distribution, steam power engineering, bridge construction, the design of masonry dams, the strength and testing of materials and machine design.

Dr. Unwin died on March 17th, 1933, in his ninety-fifth year, and thus outlived most of his contemporaries. During his long life he was the recipient of nearly every honour that could be conferred upon him by his fellow-engineers. He was President of the Institution of Civil Engineers in 1911, and of the Institution of Mechanical Engineers in 1915 and again in 1916; both Institutions conferred upon him the distinction of honorary membership. In 1921 he was awarded the first Kelvin Medal, the highest honour bestowed by British engineers. In America, where he was well known for his work on the International Niagara Commission, he received many marks of appreciation, amongst which were the honorary memberships of the American Society of Civil Engineers and of the American Society of Mechanical Engineers.

In January of last year the old students of the City and Guilds (Engineering) College published an "Unwin Memorial Number" of their journal, *The Central*. This contains a record of Dr. Unwin's life and work, mainly contributed by Mr. E. G. Walker, and reminiscences of a number of old students and friends of his. It was decided at the recent meeting that, as a first, but strictly limited, charge on the funds which it is now proposed to collect, a revised and somewhat extended memoir should be published in book form. Mr. Walker has agreed to undertake the preparation of this in an honorary capacity in collaboration with others, who may be able to furnish personal knowledge of Dr. Unwin. It is thought that many engineers and scientists would like to have such a permanent record, which can be produced in a form worthy of the subject without imposing any great liability on the funds.

After Dr. Unwin's retirement from the Central Technical College in 1904, the old students subscribed to establish the Unwin Scholarship, which has since been awarded annually to a third-year student to assist him to remain for a fourth year at the College. It is generally understood that this was approved by Dr. Unwin. Unfortunately, the income from the endowment is not large. It has been decided therefore that the subscriptions to the fund which it is now proposed to raise should be devoted principally to the augmentation of the scholarship to a value of at least £60 a year, so as to make it worthy of his name.

Finally, it was suggested that, if possible after the preceding ideas had been carried out, a portrait, bust, or bronze plaque of Dr. Unwin should be presented to the College.

In view of the foregoing proposals, the Committee desires to raise a sum of about £2500, any ultimate balance being applied to augment the endowment of the scholarship, and appeals to all who have benefited in any way by Dr. Unwin's teaching, work, and contributions to engineering knowledge to respond liberally in order to ensure a memorial on a fitting scale.

Donations should be sent to the hon. treasurer, Mr. E. G. Walker, 82, Victoria-street, London, S.W.1.

Rail and Road.

ANSWERING a question on May 1st, the Financial Secretary to the Treasury said that the proposed duty of 8d. per gallon on Diesel oil did not apply to railway Diesel engines; the existing duty of 1d. per gallon would be continued.

THE interests of the four main line companies as regards their traffic in the area controlled by the London Passenger Transport Board are watched over by the Standing Joint Committee set up by Section 31 of the London Passenger Transport Act, 1933. The passenger receipts, less operating expenses, received in the area are to be pooled and then divided in the following proportions:—L.P.T.B., 62·88 per cent.; Great Western, 1·12 per cent.; L.M.S., 4·75 per cent.; L.N.E.R., 5·80 per cent.; Southern 25·45 per cent.

THE proposals for a transport board for Northern Ireland are to be seen in the Road and Rail Transport Bill issued a few days ago. There is to be a Road Transport Board which is to acquire all the road motor undertakings and those of the railway companies. The net receipts of the Board and railway companies are to be pooled, and the pool is to be divided according to the proportions of the net receipts in the standard year, which for the road will be 1932 and for the railways the mean of 1924 and 1932. Provision is made to safeguard employees of existing undertakings and to pay compensation to those whose services are dispensed with.

IN view of the fact that Waterloo Station and yard are to be resignalled, it may be of interest to know that the first signal-box to be fixed there was provided by Stevens and Sons in 1867. It had two locking frames: one of twenty-four levers for the main lines and one of twenty-three levers for the Windsor lines. In 1874 Saxby and Freeman fixed a frame of 109 levers. That remained until May, 1892, when the present Box A was opened. The latter had a total of 220 levers in one row, but in two frames. There were 102 levers for working signals and, by the use of a gear or "route" lever and by seventy-two "simplex" selector machines, the 102 levers actuated 160 signals. That was the first of some important signalling developments, *e.g.*, at St. Enoch and Victoria, L.B. and S.C., that Mr. W. R. Sykes was connected with.

THE London Passenger Transport Board's reconstructed station at Leicester-square was opened on May 4th. It has a sub-surface circular booking hall, to which access is obtained from five street entrances. The station serves the Hampstead line by escalators on the north side of the circulating area, and the Piccadilly line by similar means on the north-east side. The shaft of the former is 117ft. 6in. long and has a vertical rise of 58ft. 9in. The escalator shaft for the Piccadilly line at Leicester-square is the longest in the world; it is 161ft. 6in. long and has a vertical rise of 80ft. 9in. This work concludes the modernisation of all the important stations in the London central area at a cost of £3,500,000. That sum is part of the £11,000,000 programme which resulted from the Development (Loans Guarantees and Grants) Act, 1929. The Western Extension of the Underground to Northfields and the Northern Extension to Cockfosters were also the result of that legislation.

THE miniature oil-engined locomotive made for the Blackpool Pleasure Beach and named "Princess Royal" by Viscount Lascelles on Tuesday, April 16th, is fitted with a forward and reverse reduction gear-box of David Brown design and manufacture, made to the order of Hudswell, Clarke and Co., Ltd., Leeds. The drive is supplied by a 32·5 h.p. two-cylinder Diesel engine running at 1000 r.p.m. The input speed through the gear-box varies from 1000–200 r.p.m. through a torque converter situated between the engine and the gear-box, giving a final axle speed in the forward direction of 148 r.p.m. in top gear and 29·6 r.p.m. in bottom gear, and corresponding speeds in the reverse direction of 155–31 r.p.m. The forward and reverse sliding gears, mounted on the input shaft, and the corresponding fixed mating gears mounted on the worm shaft, are of the straight tooth spur type made from nickel case-hardened forged steel. The final reduction is made by a high-efficiency worm gear of the David Brown patented type. This gear embodies a centrifugally cast "Taurus" bronze wheel mounted on the axle shaft, and a nickel case-hardened forged steel worm, formed solid with its shaft. All the gears are mounted on high-tensile forged steel shafts running in ball and roller bearings. The gears are totally enclosed in a cast iron case with the torque members incorporated in the gear-box cover.

WE have to record yet another centenary of the present year. It is the opening, on March 10th, 1835, of the first section of the Newcastle and Carlisle Railway, from Blaydon—3¾ miles west of Newcastle—to Hoxham, 16¼ miles. As related in the second article on July 13th, 1924, of our series "One Hundred Years of British Railways," the Newcastle and Carlisle, like the Stockton and Darlington, was a scheme for a railway in place of a contemplated canal. Smeaton proposed a canal in 1778, but, because its route could not be agreed to, it hung fire until a canal was opened, on March 12th, 1823, between the Solway Firth and Carlisle. By that time the advantages of railways were beginning to be appreciated, and eventually powers for a railway were sought and were sanctioned by 10 Geo. IV c 72, 1829. The line was of the then unprecedented length of 61 miles. A matter of historical interest relating to the opening of this first section of the Newcastle and Carlisle Railway was recorded in our eighteenth article of October 3rd, 1924. It may be remembered that the Act of 1821 that sanctioned the Stockton and Darlington made no mention of the power to be employed for haulage and that the use of the locomotive was an afterthought which was sanctioned in 1823. The Newcastle and Carlisle Act was different in that it definitely forbade the employment of locomotive power. Steam was, however, used when the line was opened and an offended landowner obtained an injunction against its use. Parliamentary sanction was at once secured to amend matters, but it was required that coke should be the only fuel to be consumed. We would add that by 4, Will. IV c 35, 1833, that most interesting line, the Whitby and Pickering, was sanctioned. It was opened from Whitby to Grosmont on May 15th, 1835.

Miscellanea.

A BRITISH company has secured the contract for the erection of a bridge to span the river Durna at Krustpils, in Latvia. The contract calls for about 1000 tons of steel and amounts to some £40,000.

A COAT of highly refractory aluminium paint has been found very effective in preventing a film of rust forming on the bottom chill plates of the casting moulds used for automobile engine valve tappets.

THE first automatic coal-sorting screens in the London area have been installed at the Deptford Wharf of the Southern Railway. These screens, which can deal with 80 tons of coal an hour, automatically grade it into three different classifications, varying from ¼in. to 12in. cubes.

IN New York, where many people live in apartments with windows facing the ventilator shaft in the lower levels of a fourteen-storey building, natural sunlight can never penetrate to the bottom of the light well. An effort to improve these conditions by introducing artificial sunlight by mounting eighteen standard floodlights at the ninth floor in two such ventilating shafts has met with success, says the *Electrician*. The lights are operated from eight to twelve hours a day, according to season.

DEALING with the influence of colloidal graphite on bearing surfaces in a recent paper before the North of England Institute of Mining and Mechanical Engineers, Mr. H. Shaw said that during some tests at the N.P.L., when the oil supply to a shaft running with a plain oil was cut off, the bearing only ran for about 45 min. before seizure showed signs of taking place, whereas a similar bearing previously run with a colloidal graphited oil ran for some 26 hours after the oil supply had been cut off before seizure seemed imminent.

IN the recent newspaper reports of a fireman receiving an electric shock when he turned a hose on to a burning building, he was said to have received the shock *via* the water jet and nozzle to the earth on which he stood. This effect was inconsistent with the results of tests carried out by the Central Electricity Board at 132 kV. Further investigation has shown that the insulation of some flexibles under the cornices had been damaged by the heat, and the fireman on entering the first-floor window, after a liberal use of water had quenched the fire, established a circuit from the electrically charged floor to the earthed nozzle held in his hand.

AMONG the amendments to the London Building Act of 1930, recommended by the L.C.C. Advisory Committee, is one that the statutory maximum height of buildings should be raised to twice the distance of the front wall of the building from the opposite side of the street, or 100ft., whichever be the less. In proposing a new standard of maximum height the Committee suggests that above that height it should be permissible to erect additional storeys with vertical enclosures. The Committee has reached the conclusion that the existing method of regulating building construction is no longer satisfactory, and that it has already wrought considerable harm on building in London.

AT the annual dinner of the Institution of Structural Engineers, which was held at the Dorchester Hotel on Friday, May 10th, with Mr. Ewart S. Andrews, the President of the Institution, in the chair, Sir Thomas Inskip, the Attorney-General, proposing the toast of "The Institution," made reference to the concrete and cement building of to-day, and put the question to the Institution whether these materials could be made to provide anything more enduring and lovely. In his reply, the President reminded Sir Thomas that, fortunately, the responsibility for concrete and æsthetic qualities did not rest upon the shoulders of structural engineers, but upon the architects. He reminded Sir Thomas that in comparing modern buildings with ancient buildings a comparison was being made only with those old buildings which had remained.

A MEETING of the General Committee of the Parliamentary Science Committee was held at the House of Commons on Tuesday, May 14th, when Sir Arnold Wilson took the chair. It was reported that recent accessions to the list of bodies allied to the Committee include the Institution of Civil Engineers, the Institute of Chemistry, and the National Veterinary Medical Association. In the period reviewed in the hon. secretary's report special mention was made of the Committee's successful efforts to secure consideration of the claims of scientific research in connection with the Metropolitan Water Board Bill now before Parliament. Other activities reported included certain aspects of the Government of India Bill, the exemption from Income Tax of funds expended on industrial research, and the claims of science and technology to representation in the higher administrative posts in Government service.

ACCORDING to Mr. S. G. Blaylock, vice-president and general manager of the Consolidated Mining and Smelting Company of Canada, Ltd., the Sullivan Mine, near Kimberley, British Columbia, provides most of the necessary ore for a daily production of 800 tons of lead and zinc, representing over 10 per cent. of the world output of these metals. The ore, however, is extremely complex, and, in addition to its lead and zinc content, there is recovered therefrom silver and minor metals, such as bismuth and cadmium, together with large percentages of sulphur and iron. Much of the sulphur is now being converted into sulphuric acid utilised in the manufacture of high-grade fertiliser. Extensive tests by the company have shown that the yield per acre of wheat on the Canadian prairies can be increased 25 to 30 per cent. by the use of this fertiliser, whilst at the same time the grade of the grain is much improved and the time of ripening advanced by ten days. Mr. Blaylock said: "The discovery of Marquis wheat which advanced the wheat crop five days, has netted hundreds of millions of dollars for the prairie farmers. Consider, then, what ten days in addition to this and six more bushels per acre will do for the prairie wheat crop." In addition, he pointed out that a great iron mine is gradually being formed on the surface near the Sullivan Mine. Every day about 2000 tons of pyrites and pyrrhotite are separated from the Sullivan ore, and stock-piled for future use."

Air and Water.

THE Portuguese destroyer "Tejo," the fourth vessel of her class to be built at Lisbon to the designs of Yarrow and Co., Ltd., has been successfully launched.

AN international gliding meeting, sponsored by the Swiss Aero Club, is to be held on the Jungfraujoch at an altitude of 11,340ft., from September 4th to 18th.

THE repairs to H.M.S. "Renown," made necessary as a result of her collision with H.M.S. "Hood" in January, have now been completed and she is leaving Portsmouth to rejoin the fleet at Scapa.

IT will be remembered that last year the fifth place in the King's Cup Air Race was taken by a biplane built by students of the de Havilland Aeronautical Technical School. The students have designed and built a two-seater, low-wing monoplane with a 130 h.p. Gipsy Major engine for the race this year.

THE new type of "Swallow" aeroplane made by the British Aircraft Manufacturing Company, Ltd., was exhibited publicly for the first time at the recent R.Ae.S. garden party. It is fitted with a Pobjoy "Cataract II" engine of 85–90 h.p. and has a maximum speed of some 110 m.p.h., a cruising speed of 95 m.p.h., and a remarkably low landing speed of about 25 m.p.h. For a tare weight of 998 lb. the maximum permissible loaded weight is 1500 lb., and tankage is provided for a range of 420 miles.

RUMOURS and statements have been in circulation to the effect that negotiations for a working agreement are taking place between the Hawker Aircraft Company and Rolls-Royce, Ltd. The second-named company informs us that its aircraft engine policy remains unchanged, and that it has no intention of entering the aircraft manufacturing business. It is the company's policy to remain free to work in the closest co-operation with all aircraft manufacturers as aero engine specialists.

AT a recent meeting of the Caves Harbour Commissioners, a letter from the Board of Trade was read concerning a combined scheme of a groyne and training bank, and the Commissioners instructed Parliamentary Agents to obtain a Provisional Order to carry out the scheme. It is hoped to gain powers in order to cope with any further modifications, though at first work would be started with the groyne only. A suggestion was made that dragging with a steam trawler might have the effect of stirring up some of the silt and causing it to be carried away on the ebb tide. The matter was left in the hands of the General Purposes Committee, with power to act.

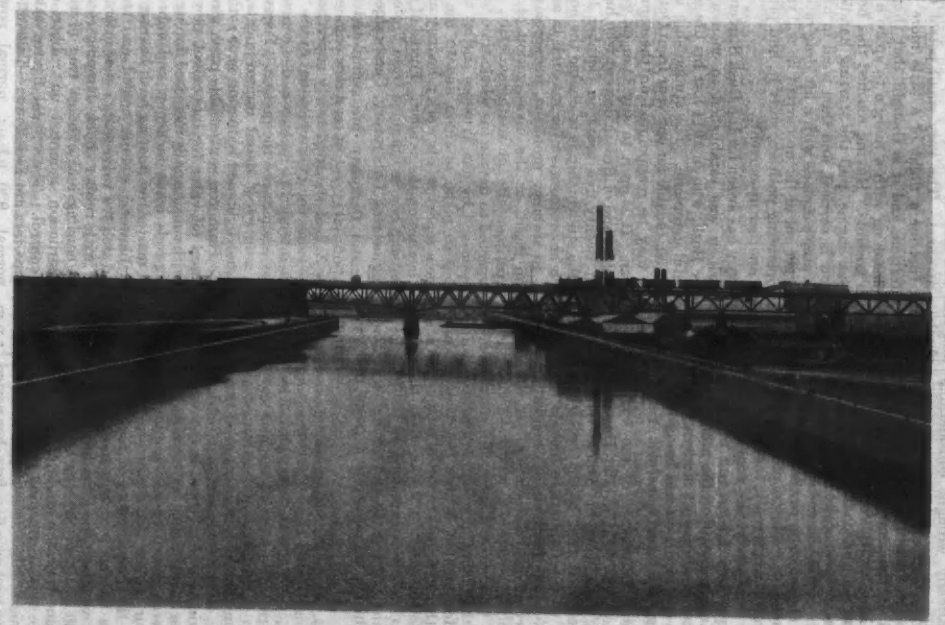
A NEW type of sailplane, which has an "occasional" power unit for getting the plane off the ground or for reaching a region of up-currents, is described in *Flight*. The machine was invented by Sir John Carden and is virtually a glider with a single-cylinder two-stroke 249 c.c. engine mounted in such a way that when not in use it may be retracted into a casing, which leaves the lines of the machine smooth and clean. The machine has been designed for a cruising speed of approximately 35 m.p.h., and this will also be the speed at which the best rate of climb is attained. The very small petrol tank contains sufficient fuel for a flight of a little more than half-an-hour's duration, and it is thought that this will be sufficient for reaching with a margin to spare a height where soaring is possible. Having reached this height the pilot will stop his engine, pull the starting handle slowly until the airscrew is vertical, and then wind in his engine. He then has a pure sailplane with a lift/drag ratio of about 24. Should he get out of the up-current he will raise his engine into the operating position, start it, and proceed until he has found another up-current.

A VACANCY has arisen for the Busk Studentship in Aeronautics, which was established in memory of Edward Teshmaker Busk, who in 1914 lost his life while flying an experimental aeroplane. The studentship is of the value of about £150, tenable for one year from October 1st; but a student may be reappointed on the same terms for a second year. It is open to any man or woman being a British subject and of British descent who has not attained the age of twenty-five years on October 1st next. The object of the studentship is to enable the holder to engage in research or preparation for research in aeronautics and especially in stability problems, meteorological questions bearing on flight, or the investigation of gusts, treated either experimentally or mathematically. The student will be expected to devote his whole time to research on a subject approved by the Trustees and at the close of his studentship to make to them and to the University of Cambridge a report on his work; he may also be asked to deliver a lecture on the subject. Forms of application for the studentship can be obtained from Professor B. Melvill Jones, Engineering Laboratory, Cambridge.

THE Bristol Company has completed a satisfactory 100 hours' official type test on a new engine, known as the "Pegasus X," of the moderately supercharged type and having the same volume and lay-out as the "Pegasus III," which it is intended to replace in due course. Externally, this engine is similar to the present "Pegasus" series, but it has a number of detail improvements, including redesigned and lightened reduction gear; the standardisation of the Hamilton controllable pitch airscrew, together with integral oil valve for its control, new and improved cylinder with substantially increased finning; strengthened connecting-rods made in a new and improved material; improved master rod floating bush bearing; modified and improved blower; sodium cooled and stellited exhaust valves and stellited valve seats; new interchangeable cone mounting with rubber shock damping attachment; new combined cowling and exhaust ring of riveted stainless steel construction mounted on rubber, and automatic mixture control. The official figures taken during the official type test are as follows:—Take-off power at 2250 r.p.m. normal, 920 b.h.p.; normal power at 3500ft., 820 b.h.p.; maximum power at 6000ft., 875 b.h.p. at 2600 r.p.m.; weight, 995 lb. net, dry; weight/power ratio, 1·08 lb. per b.h.p. The average endurance powers for the 100 hours' type test were 90 hours at 2250 r.p.m. (710 b.h.p.), 9 hours at 2140 r.p.m. (888 b.h.p.), and the last hour at normal r.p.m. at an output of 795 b.h.p. The average oil consumption throughout the test was 10·1 pints per hour.

THE CONSTRUCTION OF THE ALBERT CANAL, BELGIUM

(For description see page 504.)



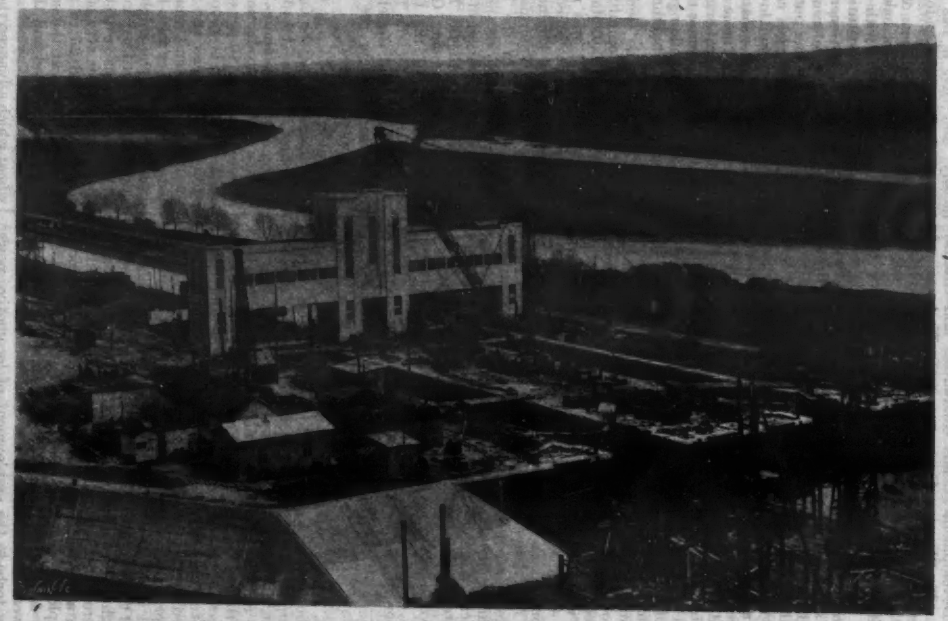


FIG. 9 (ABOVE):—CANAL NEAR HACCOURT—MAY, 1934
FIG. 10 (BELOW):—TWIN LOCKS AT PETIT-LANAYE—APRIL, 1934

FIG. 11 (ABOVE):—CANAL BETWEEN EMBANKMENTS, LIXHE-LANAYE—SEPT., 1934
FIG. 12 (BELOW):—BASIN AT LANAYE JUNCTION—MAY, 1934

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NOTICES TO READERS.

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STANDARDISATION AS A MORAL CODE.

THERE are two kinds of standardisation. One, that of dimensions; the other, that of qualities. The former came first and the latter has grown up around and upon it. Many engineers dislike the union. They welcome the standardisation—within reason—of dimensions, but object to "quality" being imposed on the manufacturer. Since it does not affect interchangeability or reduce the number of patterns, it is, they say, undesirable, and may be harmful. For, on the one hand, once a quality is standardised there is very little incentive to anyone to go beyond it; on the other, the standard may, in some circumstances, be unnecessarily high: that was the trouble in the "Buenos Aires case." "Quality" must be read in a wide sense. It does not mean only the physical properties of the materials used, but the stresses to which parts or machines may be subjected. Hence scantlings, and even design, may be fixed by it. If quality in this sense is exceptionally high, then the price also is exceptionally high. Large scantlings mean not only more material and workmanship, but greater costs of carriage. The total cost in a foreign port may therefore reach proportions which render competition with manufacturers who are working to lower standards very difficult. That was what happened, and no doubt still happens, in the Argentine.

Considered broadly, it may be said that whilst standardisation of dimensions cannot hamper a manufacturer, standardisation of quality does restrain him. It is meant to do so. It is, in fact, designed to protect the purchaser and to compel the producer to supply goods up to a specified level of excellence. No doubt we have all sub-consciously seen it in that light, but relatively few of us have looked upon it as a social device for raising commercial morals. Yet there are very ardent standardisationists who are convinced that a complete standardisation of the quality of everything would remove half the population of our gaols! Their view is that commercial laxity leads to moral obliquity; that from selling poor quality goods under the pretence that they are high quality, it is but a short step to forgery and larceny. By compelling everyone to deliver goods of standard quality, fraud would be stopped. These reformers would pass from the dimensional standards of weights and measures which the salesman is compelled to use, to standards of quality, even for the ordinary articles of commerce. Your tea and your coffee, your wine and tobacco, your piano and gramophone, the material of your clothes, the leather of your boots, the paper of your books, the wool of your blankets, the plants for your gardens, would not be subject to any variation from the appropriate specifications. The list may be extended at will. Pictures before now have been bought by the square foot and statuary by the ton. And both, despite their agreement with dimensional specifications, have been refused because the quality did not satisfy the client. If a lecture, or a sermon, or a song recital, lasts just the time specified, but is of lower quality than we expected, we feel that we have been robbed of our guineas. If the cut of a dress—a quality—does not satisfy Modom, she goes to law rather than pay the bill. In a very perfect, and very dull, world such events would never occur. We have pressed our friends' views a little bit further than they would, perhaps, be quite willing to go. But "little-by-littleism," or might we say "Eric-ism," is particularly active in standardisation circles; one thing leads to another, and an edifice of which the visionary summit is high in the clouds is being built up on precedents. Hence this idea of standardisation as a moral code may lead us far. On the face of it, it resembles the efforts to make people good by Act of Parliament. Yet such Acts, by setting up new laws, make criminals of those who break them. The "no cigarettes or chocolates after 8 p.m." law must have turned thousands of quite innocent folk into hardened offenders! But, that apart, we are by no means convinced that any great necessity to insist upon the general observance of specified standards of quality exists, or that they could be successfully enforced for the prevention of fraudulent practices.

We doubt if the purchaser is often deceived by a meretricious product. In general, he is well enough aware that if he pays a low price he must expect a low quality. He is not really taken in by the false glamour of paint and polish with which the astute salesman adorns second-rate goods. He buys cheap things because it suits him so to do, and he would justly resent any restriction which compelled him to take goods of a higher quality and of a higher price. Furthermore, he has adequate means of defending himself against imposition. If he is not satisfied with the quality of the material supplied by one shopkeeper, he can go to another. Only in the relatively rare cases where a monopoly is held by a producer or group of producers is that impossible. Hence, in general terms, it may be said that the purchaser settles the standard of quality. There is a standard for incandescent electric lamps. But thousands of users are quite satisfied with a lower standard at a lower price. To rob them of that power of selection would be unjust and we take it that even the moralists would not attempt it, even though they might desire it. Their strongest argument is that with no official standard of quality one producer's best is not the same as another producer's best. But standardisation would bring them all to a common level, and would remove a rivalry which, despite modern tendencies, we still believe to be conducive to progress. An inherent defect of any standard of quality is that since it tends to remove differences, it checks upward—as well as downward—movements.

The Art of Welding.

DESPITE the initial difficulties and discomforts which the poor acoustics of the Great Hall at the Institution of Civil Engineers imposed upon large audiences it seems to be generally agreed that the Welding Symposium on May 2nd and 3rd was a success. To-day, we report the first session, and readers will be able to form from it a good idea of the value of the papers and the discussions as a whole. The "Reporters" for each Section did their work of summarisation well, and we feel sure it will be agreed that not one of the discussions was lacking in practical qualities. We need not excuse ourselves for stressing the *practical* value of the symposium. The scientific theorist is required by the nature of his vocation to give no less attention to defects and difficulties than to merits. Since it is less troublesome to remain in the "easy-chair of custom" than to wander into unknown fields, the difficulties and objections have a tendency to prevail. It cannot too often be said that it is the business of the engineer to try everything that is not hopelessly impossible. If he allows himself to be frightened by the bogeys of the theorists he will make no progress. It is not that the theorists are certain to be wrong. In nine cases out of ten they are quite right. But nearly always in practical engineering ways and means of overcoming objections are discovered by those who have the courage to make the attempt. In this country we have been, perhaps, a little too cautious about the adoption of welding. That arises from the exceptional standard of safety which is usually insisted upon by British engineers. We have a tendency to err on the safe side and to employ factors which are higher than those commonly employed in other countries. Good as that practice may be, it has the defects of its merits; it sometimes tends to hold progress in check. There seems to be a fairly general belief that it has done so in the case of welding, an art in which we are not so far advanced as the Continent and America. We shall be surprised, indeed, if the Symposium does not result in a rapid improvement in our position.

One of the facts which impressed those who attended the meetings and cannot fail to strike those who read our reports, was the anxiety which every one showed to share his knowledge and experience with others. No doubt a lot of shop secrets were kept back, but, on the other hand, a great many were given away. A single spirit seemed to inspire the meeting—to foster and encourage the use of welding. It was a congress of proselytes. Every speaker seemed to be anxious to convert everybody else to his belief that welding was better than riveting. Of course, there were differences of opinion—plenty of them. But they were not differences about the merits of welding, but about the means of attaining the best results. The question of the removal of strains set up by welding kept cropping up at the sessions, and is clearly one on which differences of practice prevail with, apparently, little difference in results. May we have the great temerity to suggest that if we look after the stresses the local initial strains will look after themselves? The Chief Engineer to the German State Railways asserted that, generally speaking, "too pessimistic a view was taken of the stresses remaining in the work as the result of distortion and contraction." Another problem which is still unsolved is that of bare *versus* coated electrodes. The discussions which revolved about it left upon our minds the impression that there is a right place for one and a right place for the other, and that no sweeping assertion can justly be made. Given appropriate conditions experience appears to show that there is no practical reason why the more economical bare electrode should not be used. The nature of the steel that may be safely welded was yet another question which remains to be answered, and will only be answered by continuous experiment. Dr. Hatfield holds the view that with appropriate technique all classes of special steels can be welded if the deposited metal is the same as the parent metal. Other metallurgists were not prepared to go so far, but it was very evident that even the most cautious did not give up all hopes that with further knowledge and experience the difficulties presented by some of the more complex steel alloys would be overcome. The Symposium was concerned with welding of all kinds and for all purposes. It brought to the front a new word, which will have to be accepted by the lexicographers. We speak of forgings and castings, and now, cousin to them, we have "weldings" as a generic name for fabricated articles. To weldings as much attention was paid as to structural welding, repair work, and the welding of pressure vessels. On all these subjects a great deal of very useful matter was presented, and much direct information based on experience was given, not alone by foreign, but by British speakers.

The real and only grave obstacle to welding is uncertainty about the results, but by degrees that obstacle is being worn away, and before many years have passed inspectors will be in a position to satisfy themselves more thoroughly concerning the quality of welds than they can concerning riveted joints. The splendid work being done at Woolwich by Dr. Pullin is leading rapidly towards that end. It is being furthered by the activities of firms which are producing X-ray equipment. Interpretation still remains, as with much X-ray work, a difficulty, but with greater experience signs difficult to interpret will become rarer and the full significance of others will be appreciated. By a remarkable group of photographs reproduced in our issue of April 19th, Dr. Pullin showed that a group of expert welders, all working under identical conditions with identical material, would produce welds with

marked differences. Out of six only one was perfect. But, fortunately, that does not mean that the others, or some of the others, would not have been quite good enough for service. Other workers, like Mr. Schuster, are attacking the problem of testing from another angle. They are seeking for a practicable physical workshop test which can be applied to welded joints, whilst yet others are devising means for making electrical and magnetic examination of joints. All this is to the good. but, after all is said and done, the best testimonial that welding can be given is its success in actual weldings and structures. Examples were given by the score at the meetings. The majority came from abroad, but British examples are increasing in number, and we trust they will continue to increase, even whilst we are still seeking for the means to prove that every weld is sound, and to find methods which shall always ensure the attainment of that object.

Literature.

The Profession of Chemistry. Prepared under the supervision of the Publications Committee of the Institute of Chemistry, by Richard B. Pilcher, Registrar and Secretary. Published by the Institute, Russell-square, W.C.1.

We welcome heartily this, the third, edition of Mr. Pilcher's well-known monograph. There is no better guide to the chemical career and no book that can be more safely recommended to young men and women and their parents and guardians. We may, moreover, add that Mr. Pilcher has a literary style rather rare in technology, and that this monograph is much more than an ordinary guide to a profession. Parents with an eye to the future will appreciate his remark that young chemists "in general, at least at the commencement of their careers, seek knowledge rather than affluence; but it is necessary and desirable that they should have regard to material rewards, for the status of their profession depends to a large extent upon its remuneration."

To the present edition there has been added a chapter on "Scientific Journalism and Authorship," which contains much sound advice and useful information. We sincerely commend Mr. Pilcher's opinion that "Every scientific student should cultivate the art of ready expression, and if possible something of style. He should be able to present in easy, natural language a record of what he is doing." It cannot be said too often that any subject, however scientific or technical, gains by being presented in a good literary form. Perchance, there are still some of "that kind of men" known to St. Augustine "who even suspect truth itself, and will not assent to it, when delivered in polite and elegant speech." We trust they are growing rarer. But we suspect that much of the terror with which science is regarded by a great many people is largely the result of the appalling dryness of text-books and papers. Facts and opinions may be stated with as much accuracy and with more certainty of effect in language that appeals than in language which repels.

SHORT NOTICES.

A Symposium on Illumination. Edited by C. J. Webber Grieveson, B.Sc. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 13s. 6d. net.—This volume contains a series of ten lectures given during the spring of 1933 under the auspices of the National Illumination Committee of Great Britain and the Illuminating Engineering Society. The contents are as follows:—Lighting in the Service of Mankind, by C. C. Paterson; Radiation: Light and the Eye, by J. W. T. Walsh; Electric Lamps and their Characteristics, by W. J. Jones; Gas Lamps and their Characteristics, by F. C. Smith; Daylight: Coloured Light, by J. W. T. Walsh; Photometric Standards, Lamp Photometry and Illumination Measurements, by J. T. MacGregor-Morris; The Redistribution of Light, by G. H. Wilson; Lighting for Decoration and Entertainment, by A. B. Read; Public Lighting, by J. F. Colquhoun, and Lighting for Safety, Health and Welfare, by H. C. Weston. The book is well produced and illustrated and will doubtless prove very interesting to all students of illumination.

Common Features of Fire Hazard. By J. J. Williamson. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 6s. net.—This textbook deals with a subject which concerns every branch of industry, and the author has, in a concise manner, covered all the phases of fire danger. It opens with a chapter on the common causes of fire and fire first-aid appliances, followed by sections dealing with various types of construction, their susceptibility to fire, and protective measures; fuels; combustion; inflammable liquids, vapours and gases; dust explosions; celluloid; paint spraying; electricity; dangerous goods; lighting, heating, and ventilation; and concludes with a bibliography of books which deal with fire risks. Although most people are familiar with the fire dangers of their own particular industry, the book should prove useful to those dealing with the subject of fire hazard in a general way, especially when connected with industrial construction and insurance.

The Twenty-four-Foot Wind Tunnel at Farnborough.

No. IV.

(*Continued from page 471, May 3rd.*)

The Model Balances.

Within the superstructure of the building, as already explained in general terms, provision is made for mounting a scale model of a complete machine, or of a component, on an aerodynamical balance and for lowering the model and balance down into the wind current flowing across the working space below. The equipment includes two identical balances and two carriages beneath which the balances

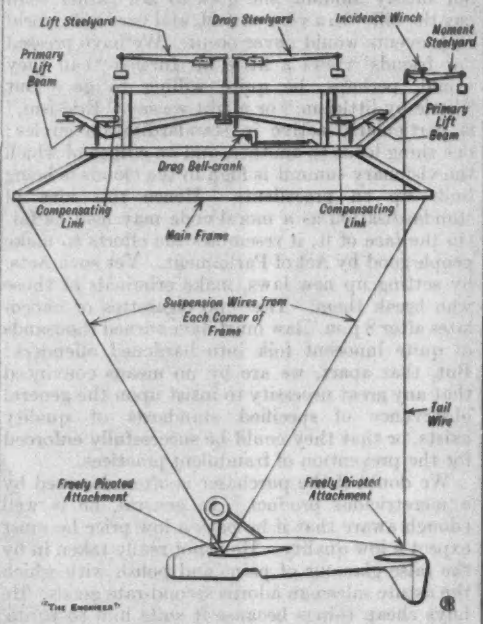


Fig. 25—Model and Model Balance

are slung and a central lift by means of which either carriage together with its balance and model may be lowered or raised into or out of the wind stream. The carriages and balances are duplicated in order that while one model is being tested another may be undergoing preparations for testing. Scale models up to about 18ft. span may be accommodated on the balances. From this point of view the tunnel extends considerably the range of model sizes which may be tested in this country.

The main aerodynamic balance, described in our previous article, determines simply the magnitude of the resultant vertical and horizontal forces acting on the full-size machine or component mounted upon it. As previously stated, however, some form of stress-measuring strut, not yet designed, may be added to it in the future to enable the moment applied to the machine by these forces to be measured thereby permitting the line of action of the resultant force to be determined. In the model balances—see Fig. 25—provision has been made from the outset for measuring the vertical and horizontal forces acting on the model and the moment which, together, these forces exert. Except for the fact that the model is slung, upside down, below the platform or main frame of the balance instead of being supported, right way up, on top of it the design of the model balances is up to a point kinematically identical with that of the full-scale balance. The platform is carried on two beams linked at their inner ends to the lift steelyard, the connection between the beams and the platform being made, as before, by means of parallel motion compensating links. The horizontal force acting on the platform is transmitted to the drag steelyard through a bell-crank lever. The additional feature consists of a third steelyard mounted not on an independent base as are the other two but on the platform itself. From the four corners of the underside of the main frame wires are taken diagonally to pivoting attachments fixed to the underside of the wings of the model. A fifth wire is led from a similar attachment near the tail end of the model upwards to the third, or moment, steelyard mounted on the main frame. The attachment of this wire to the steelyard is effected by means of a small winch which enables the incidence of the model relatively to the direction of the wind to be adjusted.

When the model is subjected to the reaction of the wind the tension in the rear, or right-hand, pair of diagonal wires, is reduced and that in the two forward diagonal wires increased. In this condition the force measured at the drag steelyard will be equal to the horizontal force acting on the model. The force measured at the lift steelyard will be the weight of the model plus the lift developed plus the weight of the main frame and certain of its levers including the moment steelyard and its poise. The position of the poise on the moment steelyard does not affect the force measured at the lift steelyard. The quantity measured at the moment steelyard is a force not a moment. This force multiplied by the distance between the points of attachment of the tail wire and the diagonal wires gives the moment sought, namely the resultant moment of the weight of the machine and the lift and drag developed by it taken about the point of attachment of the diagonal wires. Knowing this moment, the weight and centre of gravity of the model and the magnitudes of the

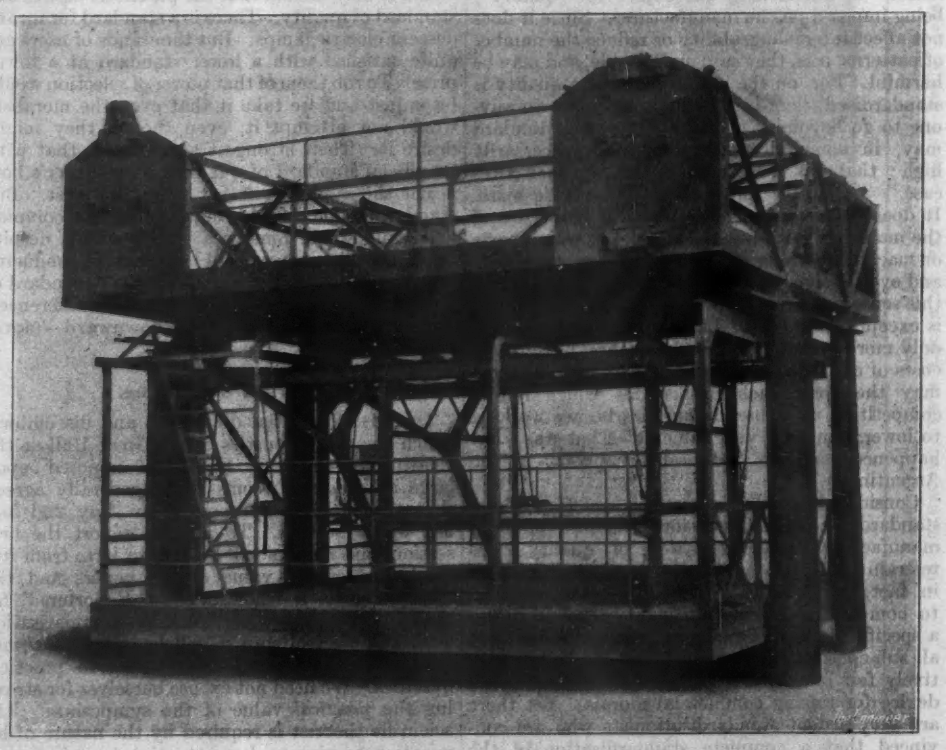


Fig. 26—Lift Carriage and Balance Car

lift and drag developed it is possible to determine the line of action of the resultant aerodynamical force acting on the model and its point of application.

The two model balances were designed and constructed at Farnborough by the R.A.E. staff.

THE BALANCE CARS AND LIFT.

The contract for the construction of the two balance cars and the central lift was entrusted to Clarke, Chapman and Co. Ltd. of Gateshead-on-Tyne. In Fig. 26 we illustrate the lift carriage with one of the balance cars suspended beneath it as assembled at the makers' works for deflection tests. In use, as indicated in Fig. 11 *ante*, the balance described above, is mounted within an opening left in the floor of the balance car and the model is slung from the balance by means of the wires as previously mentioned. The model, balance and balance car are then run forward out of the model bay in the superstructure on to rails on the underside of the lift carriage which is thereupon lowered. In the lowered condition the model is aligned approximately with the axis of the jet of wind and the floor of the lift carriage makes a close, sound-resisting fit within the central well of the superstructure. The noise of the wind flowing through the tunnel when it is at work is very considerable and for the sake of the comfort of those working in the offices &c. of the superstructure it is desirable to exclude it as much as possible. When a full-scale test is in progress the lift carriage, with the balance car withdrawn from it, is kept in the lowered position. During a model test observers are stationed on the balance car and descend with it. They may at any time withdraw from it by ascending a ladder leading to a sound-resisting trap door in the floor of the lift carriage.

Each of the balance cars is built of welded steel framing which forms a cage measuring 18ft. 4in. by 19ft. 8in. with a height of 8ft. 4in. It is covered with removable flooring except for the opening measuring 9ft. 1in. by 5ft. 10in. within which the model balance is fixed. In the construction of the cars the workmanship required was of a very high order for the condition as to the rigidity of the structure laid down in the specification was exacting. In addition to its own weight each car was required to carry a specified load totalling 3¾ tons consisting of the weight of the model, 5 cwt., the weight of the aerodynamical balance, 1 ton, a resultant downward aerodynamical force on the model of 2 tons and a live load of 10 cwt. representing the weight of the observers. It was required that under this specified load the distortion should change the levels of the ends of the frame supporting the balance by not more than one ten-thousandth part of the length of the frame. As the frame is 8ft. 9in. long this requirement implied that under load the change in level caused by distortion was not to exceed 0·0105in. The cars are slung from the overhead rails in the model bays by means of ball-bearing rollers and are propelled forward on to the rails on the underside of the lift carriage by means of hand chain drives.

The lift carriage is a welded steel structure measuring 21ft. by 19ft. 8in., and is guided between four vertical rails. In the lowered position the floor of the carriage beds against a rubber tube insertion let into wooden curbing surrounding the central well opening in the first floor of the superstructure. The actual weight of the carriage and the attached loaded balance car is taken on four steel blocks inserted in the wooden curbing two at each end. Against these blocks the ends of the rails on the underside of the lift carriage bear. These blocks transmit the whole of the load to the reinforced concrete floor of the superstructure. They are of wedge construction in order that the level of the carriage when in the lowered position may be adjusted to eliminate inaccuracies arising during the construction of the building or subsequently by deformation, shrinkage, or other cause.

The lift carriage is suspended by eight ropes, two at each corner. Each rope has a factor of safety of 15. In Figs. 27 and 28 we illustrate the means of attachment of the ropes to the carriage. The two ropes at each corner are coupled to a compensating lever to which the weight of the carriage is transmitted through an eyebolt supporting a spring, the load being applied to the top end of the spring by a bracket bolted to the side of the carriage. The support of the carriage in this manner on four springs is designed to cause it to come to rest against the stops in its lowest position without shock and similarly to start its upward motion also without shock. Combined with the spring suspension there is a safety gear which comes into operation if one of the ropes breaks or stretches unduly. In that event the compensating lever would tilt in one direction or the other and in so doing would cause a roller at one of its ends to move a "balance lever." The movement of this lever is in the same direction whichever rope breaks or stretches and results in the release of a trigger. With the trigger released a tension spring becomes free to turn a shaft—the shaft on which the balance lever is loosely mounted—and, through a coupler, a second parallel shaft on the other side of the suspension spring. These two shafts at their inner ends carry toothed cams which when the trigger is released and the shafts rotate are pulled by the tension spring against the edges of the vertical guide rail. The grip of the cams tightens under the weight of the carriage and prevents its farther movement. Simultaneously the rotation of the second shaft actuates a switch which cuts off power from the lift motor.

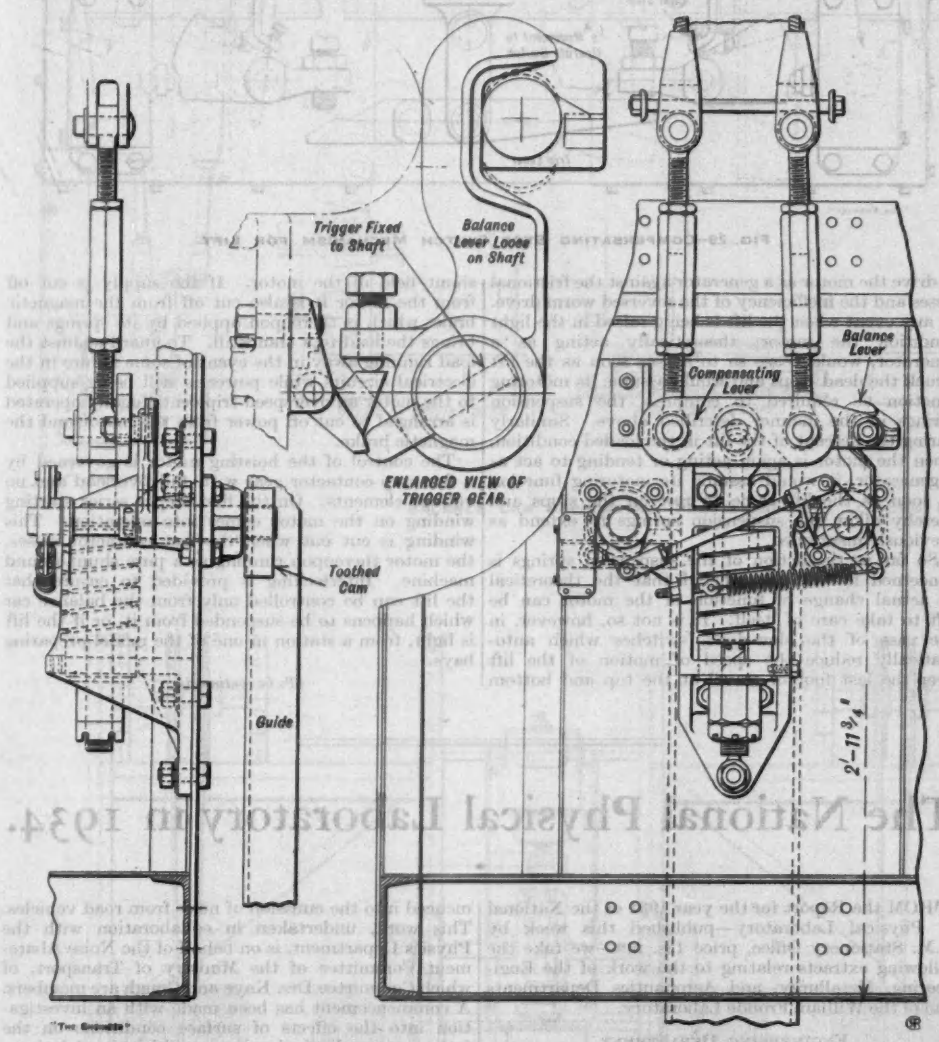


FIG. 27—LIFT ROPE ATTACHMENT AND SAFETY GEAR

In other directions equally close attention has been given to questions of safety. It is clearly essential to provide some means of securely locking the balance car to the rails on the underside of the lift carriage to prevent movement of the balance car when it is lowered into the wind jet. It is equally important to provide means of locking the balance car to the rails in the preparing bay in order that it may not move when the lift is in the lowered position. The same lock serves these two purposes. Details of its design are given on page 519. Each balance car is suspended from the rails of the preparing bay or of the lift carriage by means of six four-wheeled trolleys, three on each rail. The wheels of the middle trolley on each side of the car are connected by chain drives to hand-operated cranks whereby the car may be propelled out of or into the preparing bay. Each of the remaining four trolleys is provided with a locking gear consisting of a pair of cams which can be pulled into contact with a plate on the underside of the rails by means of a handle and a pair of extensible rods. In addition at one end of the car the two trolleys are furnished with a locking bolt which engages with a hole in the plate on the underside of the rails. This bolt lies midway between the two cams and is raised into the locking position during the final portion of the movement of the cam-operating handle. During this final portion of the handle movement, the handle makes contact with a switch. This switch is in the hoisting motor circuit and ensures that the lift cannot be operated

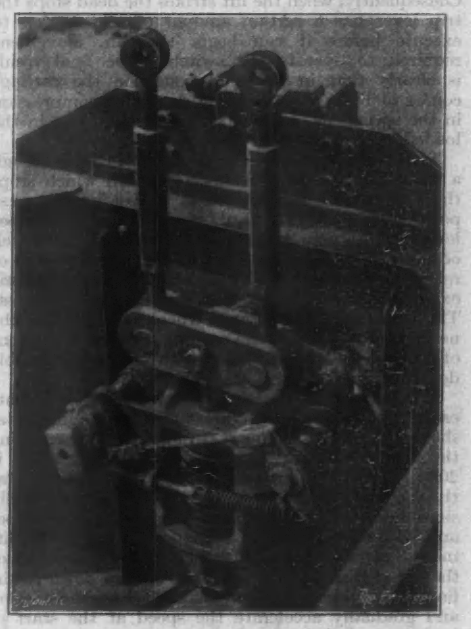


FIG. 28—ROPE ATTACHMENT

one way or the other unless the balance car is locked to the rails of the lift carriage or to the rails in the model preparing bay.

When the lift carriage is in its highest position the gap between the ends of the rails on its underside and the ends of the rails in the model bay does not exceed ¼in. This clearance is governed by the vertical guide rails in the well hole and by adjustable gun-metal shoes on the lift carriage.

In order to avoid transmission of shock to the balance car, the balance and the model, it is important that when the lift carriage is in its highest position its rails and those in the model bays should be at the same level very exactly whether the carriage is loaded or light and that no change in the level of the lift carriage rails should occur while the balance car is being moved on to, or off, the lift carriage. These requirements have to be regarded in conjunction with the facts that the lift carriage is spring suspended and that it weighs 9 tons when light and 16 tons when the fully laden balance car is suspended from it.

To bring the lift carriage to rest in either the light or loaded condition with its rails properly aligned with those in the model bays would by itself not present a very difficult problem. It might for instance be achieved by means of a dead stop, a switch on the side of the well hole and a finger on the side of the lift. The finger and switch would be arranged to cut out the hoisting motor when, or very shortly after, the lift touched the dead stop. Such an arrangement would not, however, fulfil the other requirement, that no change in the level of the lift carriage rails is to occur while the balance car is being moved on to or off the lift carriage. With the simple arrangement indicated the lift, light or loaded, would come to rest at the level determined by the dead stop, but it would do so with less compression in the suspension springs in the light condition than in the loaded. The strength of these springs is such that the actual difference of compression would be about ¼in. Hence, if the lift were

brought up light and one of the balance cars was run on to it the lift rails would lose height to that amount while the car was being run on.

The object to be secured in order that the requirement may be fulfilled is to bring the lift against the dead stop with the same degree of compression in the suspension springs when the lift is light as when it is loaded. In other words means must be provided which, when the lift is light, will delay the switch cut-out sufficiently to allow the hoisting motor to compress the suspension springs to equality with their compression in the loaded condition of the lift.

The mechanism adopted for this purpose is shown in Fig. 29. At one corner of the lift carriage the lower end of the spring suspension eye bolt is linked to a trip lever fulcrumed on a pin which is fixed relatively to the lift carriage. In the engraving the full lines represent the configuration of the parts just before the lift, in the loaded condition, strikes the dead stops of which there are four, one on each of the vertical guide rails. The left-hand end of the trip lever is in contact with the tail of a cam the edge of which engages with a push switch. The carriage having come to rest against the dead stops, the continued operation of the hoisting motor will compress the suspension spring and thereby, through the links, lift the trip lever about its fulcrum. A movement of $\frac{1}{2}$in. at the end of the trip lever is sufficient to cause the cam to operate the switch and stop the motor. If the lift carriage is light there is less compression in the suspension spring and, relatively to the lower end of the links supporting the trip lever, the fulcrum pin is $\frac{1}{16}$in. higher than its position shown by the full lines. In the light condition the trip lever therefore occupies the position shown dotted. Consequently, when the lift strikes the dead stops the trip lever has a certain amount of idle motion to execute before it can begin the $\frac{1}{2}$in. movement required to operate the switch. The final result is clearly that in the light condition the carriage comes to rest with the same degree of compression in the springs as exists when it comes to rest in the loaded condition.

The right-hand end of the trip lever, through a second cam, operates another switch which stops the motor when the lift comes to rest in its lowest position against the dead stops at the first floor level. In this case the delay in the action of the switch occurs in the loaded condition. It has the effect of releasing the compression in the springs to the same extent when the lift is loaded as when it is light. This point is of importance when we remember the necessity for starting the ensuing upward movement of the lift and balance car with the least possible degree of shock.

The lift is counterbalanced by two cast iron weights each of 5½ tons which are fitted with gun-metal shoes for running on round steel guide rods ascending the well hole. Its designed speed of operation is 20ft. per minute but over its last foot of travel at the top and at the bottom the speed is automatically slowed down to 1ft. per minute by means of an upper and a lower slow-down switch with which the lift makes contact. These switches gradually reduce the speed from the full 20ft. per minute down to the final 1ft. per minute. They act in the reverse direction and gradually accelerate the speed at the start of lowering or hoisting.

The Lift Carriage Winding Machinery.

The general arrangement of the overhead winding machinery for the lift carriage is shown on page 519. This machinery is mounted at the top of a tower-like portion of the superstructure raised above the well hole—see Fig. 9 *ante*.

Each of the two winding barrels is grooved to take four of the hoisting ropes and two balance weight ropes. From the barrels the ropes pass to the corners of the lift carriage, or to the balance weights, over cast steel guide pulleys mounted in pairs on fixed shafts. These pulleys are free not only to rotate on their shafts but to slide axially on them in order that they may automatically take up their correct positions as the ropes wind off or on to the barrels. The boss of each pulley is cored out to form an oil reservoir for the self-lubrication of the white-metal lined bearing with which the bore of the boss is fitted. The two winding barrels are coupled through spur gearing to a common shaft which is driven through reversible worm gearing at the middle of its length by a 19 b.h.p. shunt-wound motor running at 500 r.p.m. Quite independent of the main hoisting machinery there is a 10 cwt. general-purpose hoist consisting of a rope and hook which can pass down through a soundproof door at the centre of the lift carriage to the ground level. The barrel for this auxiliary hoist is driven by an independent motor through worm gearing at a hoisting speed of 40ft. per minute. The guide pulley, like those for the main lift, is free to rotate and slide longitudinally on a fixed shaft. The four edges of the hole in the lift carriage through which the rope passes are fitted with roller fairleads to protect the rope from chafing. Overwinding of the auxiliary hoist at the top or bottom of its motion is prevented by means of switches operated by a shaft driven by a chain from the barrel.

As previously stated, the lift when light weighs 9 tons and when loaded with a balance car, 16 tons. The two counterbalances together weigh 11 tons. Hence when the lift is light the balance weights are 2 tons heavier than the lift, and in the loaded condition, the lift, plus the balance car &c., is 5 tons heavier than the balance weights. It follows therefore that the function of the motor is dependent not only upon the direction of movement of the lift but also upon whether it is light or loaded. Neglecting all frictional losses and the loss of efficiency at the reversible worm drive we may say that in the loaded condition the motor has to apply driving power to raise the lift while to lower the lift it has to act as a generator and return power to the supply circuit. In the light condition these functions are reversed the motor having to develop driving power during the lowering of the lift and to act as a generator while the lift is being raised. In actual use, we understand, the unbalanced load is hardly sufficient to drive the motor as a generator against the frictional losses and the inefficiency of the reversed worm drive. In any event when the lift is being raised in the light condition the motor, theoretically acting as a generator, would cease so to act as soon as the lift struck the dead stops and would assume its motoring function as required to compress the suspension springs in the manner described above. Similarly during the descent of the lift in the loaded condition, when the motor is again acting or tending to act as a generator, it would assume its motoring function as soon as the lift came to rest on the stops and thereby allow the suspension springs to extend as previously mentioned.

So far as the action of the suspension springs is concerned it will be gathered that the theoretical or actual change of function of the motor can be left to take care of itself. It is not so, however, in the case of the slow-down switches which automatically reduce the speed of motion of the lift over the last foot of travel at the top and bottom of the motion. When the lift is rising in the loaded condition the upper slow-down switch has to reduce the speed of the motor under a heavy load. When the lift is rising in the light condition the same switch has to slow down the speed of the motor under a light load or possibly when acting as a generator. A load-discriminating relay is provided to distinguish between these different conditions. This relay controls five armature-diverter contactors with which diverter resistances are associated. The relay and contactors operate in a similar manner when the lift is being lowered.

A slipping clutch is embodied as an emergency safety device in the motor drive but normally it takes no part in the operation of the lift. A magnetic brake is also provided and is arranged across the shunt field of the motor. If the supply is cut off from the motor it is also cut off from the magnetic brake which is thereupon applied by its springs and brings the load to a standstill. To guard against the load running away in the event of some failure in the electrical circuits while power is still being supplied to the motor an overspeed trip centrifugally operated is arranged to cut off power from the motor and the magnetic brake.

The control of the hoisting motor is governed by a five-step contactor gear with full overload and no voltage elements. On the first step a series starting winding on the motor comes into operation. This winding is cut out when the last contactor closes, the motor thereupon running as a pure shunt-wound machine. Interlocking is provided to ensure that the lift can be controlled only from the balance car which happens to be suspended from it, or if the lift is light, from a station in one of the model preparing bays.

(To be continued.)

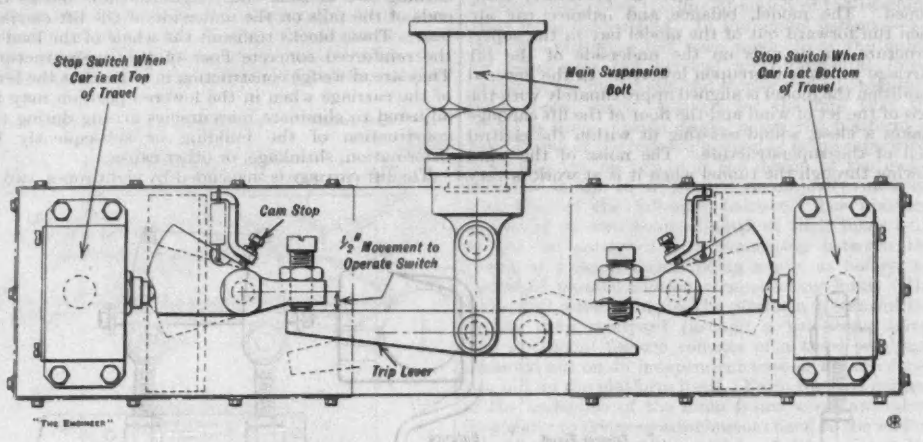

Stop Switch When Car is at Top of Travel
Main Suspension Bolt
Stop Switch When Car is at Bottom of Travel
Cam Stop
½" Movement to Operate Switch
Trip Lever
"The Engineer"

FIG. 29—COMPENSATING STOP SWITCH MECHANISM FOR LIFT

The National Physical Laboratory in 1934.

FROM the Report for the year 1934 of the National Physical Laboratory—published this week by H.M. Stationery Office, price 13s. net—we take the following extracts relating to the work of the Engineering, Metallurgy, and Aeronautics Departments and of the William Froude Laboratory.

Engineering Department.

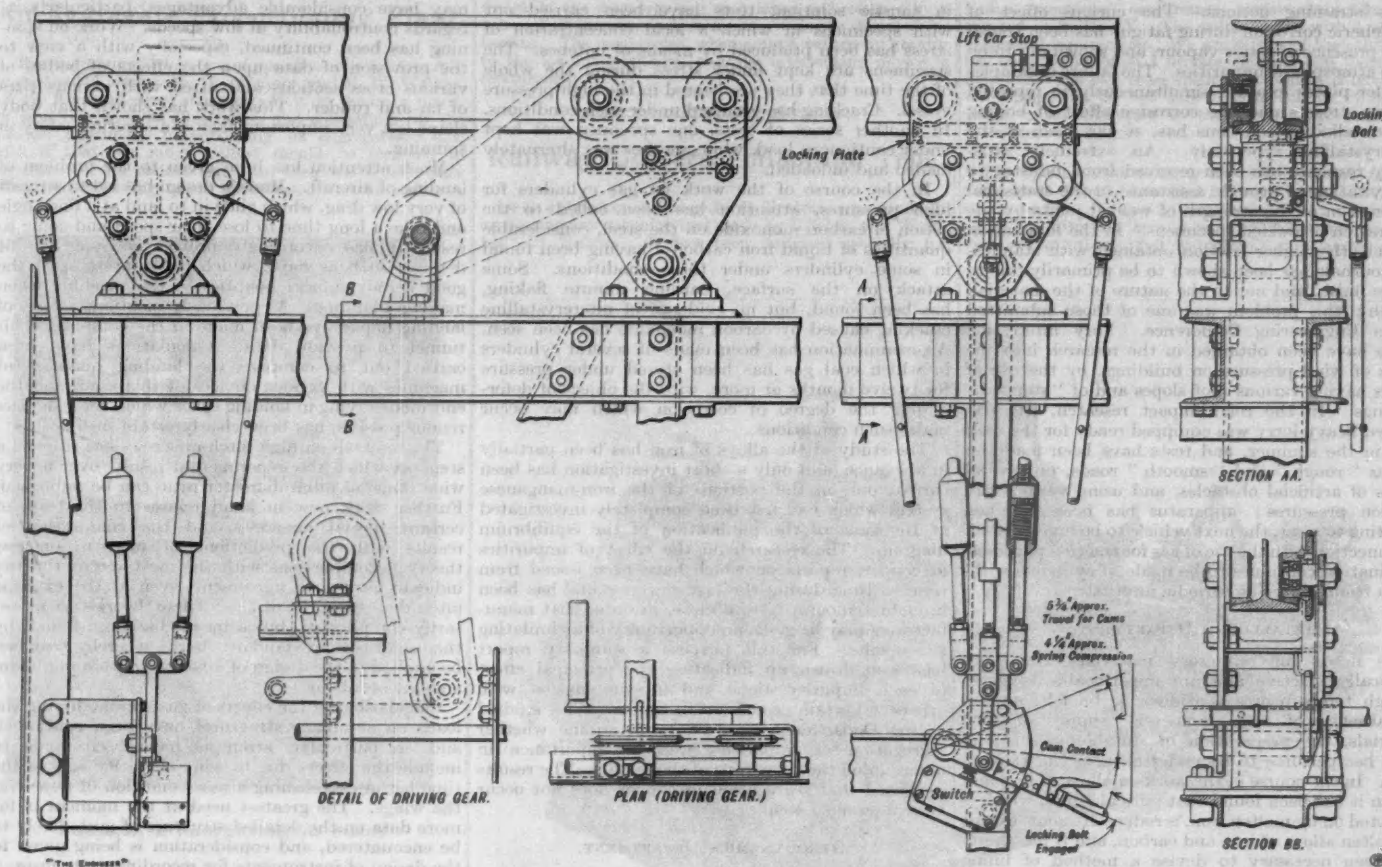
Of the new researches commenced during the year, mention may be made of the following :—An investigation of the lubricating value of synthetic oils derived from coal has been commenced in conjunction with the Fuel Research Station, where the oils are prepared. A special testing machine has been designed and constructed for this work. An investigation into extreme pressure lubricants has also been started ; two new testing machines are being obtained for this purpose. Under the direction of a representative Committee formed by the Institution of Mechanical Engineers, a research has been commenced to investigate on behalf of the Institution and the Department of Scientific and Industrial Research, the principles of design required in the construction of satisfactory pipe joints for high-pressure and high-temperature service. A new attack on the fundamental problem of fatigue failure has been commenced by the study of the crystalline structure of metals, using X-ray methods of precision. This is a joint research with the Physics Department. A new study of the type of corrosion produced between metallic surfaces in contact, when subjected to relative motion, has already produced interesting results. Previous work on the stability of thin flat metal panels for aircraft construction has been extended during the year to curved panels. The high-speed wind tunnel has been successfully converted to the open-jet type, following interesting experimental development work. An investigation has been commenced into the emission of noise from road vehicles. This work, undertaken in collaboration with the Physics Department, is on behalf of the Noise Abatement Committee of the Ministry of Transport, of which Committee Drs. Kaye and Gough are members. A commencement has been made with an investigation into the effects of surface conditions on the fatigue strength of wires ; a new high-speed fatigue-testing machine has been designed for the purpose.

Turning to completed items of research, the following may be mentioned :—The investigation into the methods of testing thin sheet metal has been brought to the final report stage. The programme of work on the design and standardisation of lifting gear components is completed ; as a result, new specifications for hooks, rings, alternative links, egg links, and single, double, and four-legged slings have been issued by the British Standards Institution. The study of the plastic creep of a lead beam subjected to plane bending couples has been completed, with very interesting results. An investigation of the mechanical properties of electrically welded chains of foreign origin is now finished ; an interesting development of this work, in collaboration with a group of industrial firms, appears probable. The investigation of the width of front of wind gusts on the Severn Bridge has yielded sufficient information for the purpose, and it is proposed to dismantle the apparatus.

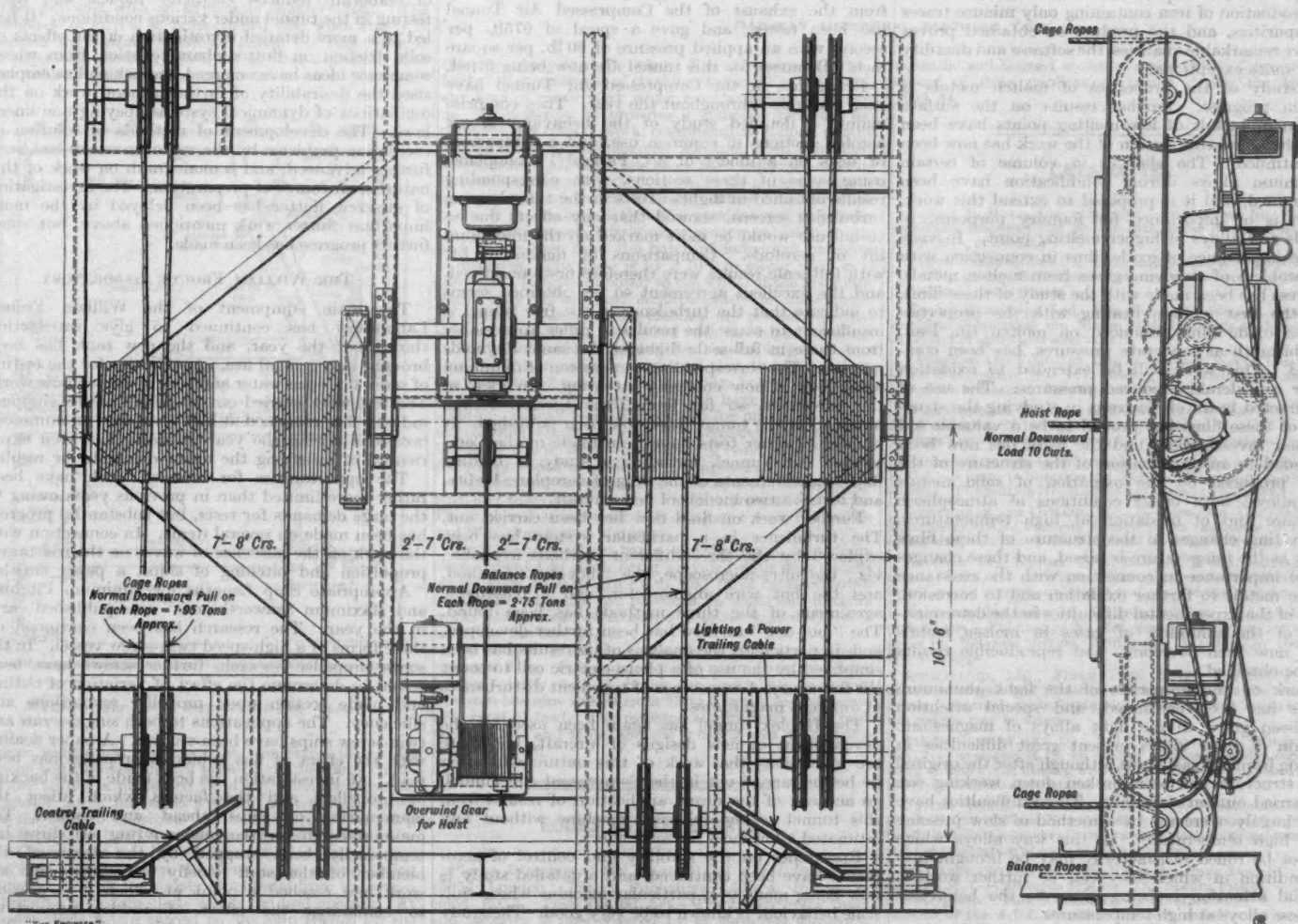
Of the investigations still in progress in the Department, a number have reached an interesting stage of development. Satisfactory autographic oscillograph records are now being obtained during high-speed fracture of metals under impact. In the research into belt transmission, humidity effects have been traced as the cause for variations in results which had occasioned some misgivings. The preliminary work on injectors has been satisfactorily completed, and specific industrial applications are now receiving

R.A.E. 24-FOOT WIND TUNNEL — BALANCE CAR AND LIFT

CLARKE, CHAPMAN AND CO., LTD., GATESHEAD-ON-TYNE, ENGINEERS



BALANCE CAR SUPPORTING, PROPELLING AND LOCKING EQUIPMENT



HOISTING MACHINERY FOR LIFT CARRIAGE

attention. Marked success has attended the research into combined fatigue stresses. The new machines have worked excellently and a first report has been made on the behaviour of metals under combined bending and torsional stresses. An interesting general relation has been found for steels, while single crystals have been shown to obey the same general law of deformation under complex stresses as under simple straining actions. The curious effect of atmospheric corrosion during fatigue has been traced to the presence of water vapour, and shown not to be due to atmospheric impurities. The failure of samples of boiler plates exposed simultaneously to repeated bending stresses and the corrosive effect of boiling aqueous alkaline solutions has, so far, been of the transcrystalline type only. An extremely satisfactory response has been received from industry to the invitation to provide assistance in the statistical examination of the strength of welded joints by the preparation of welded specimens. In the lubrication research, the higher friction obtained with stainless steel journals has been shown to be primarily due to surface finish, and not to the nature of the material, as such; this problem was one of those submitted to the Engineering Conference. Very interesting results have been obtained in the research into the effects of wind pressure on buildings, by the use of models having various roof slopes and of "stepped" buildings. In the road impact research, the six-wheeled heavy lorry was equipped ready for the road early in the summer, and tests have been made on various "rough" and "smooth" roads, on several shapes of artificial obstacles, and using various tire inflation pressures; apparatus has been designed for fitting to a car, the next vehicle to be investigated. In connection with the use of gas for traction purposes, examination continues to be made of cylinders withdrawn from service at periodic intervals.

Metallurgy Department.

The needs for refractory materials which are chemically inactive and are impermeable to gases at high temperatures continues to be felt, and in the absence of any commercial supply of such materials, the preparation of suitable vessels and tubes has perforce to be undertaken in the Department. In the course of the work on alloys of iron and carbon it has been found that pure alumina, which is not acted on by molten iron, is reduced to some extent by molten alloys of iron and carbon, and it has therefore been necessary to devise a method of lining crucibles and of coating thermo-couple tubes with thoria in order to prevent this action. Although the amount of aluminium taken into the iron in this way is very small, it is important that the metal used in the investigation should be of the highest possible purity. Further improvements have been made in the production of iron containing only minute traces of impurities, and the product so obtained proves to have remarkable qualities, the softness and ductility being quite exceptional.

A study of the properties of molten metals is still in progress. Further results on the surface tension of metals of low melting points have been published, and this section of the work has now been discontinued. The changes in volume of certain aluminium alloys during solidification have been determined, and it is proposed to extend this work, which is of importance for foundry purposes, to metals and alloys of higher melting point. In view of the importance of oxide films in connection with the problem of removing gases from molten metals, progress has been made with the study of these films, and the first section, dealing with the properties of the oxide films produced on molten tin, lead, and bismuth at moderate pressures, has been completed. This work will be extended to oxidation under considerably reduced pressures. The use of a diffracted beam of electrons in studying the structure of these films has proved to be a valuable aid to their investigation, and the work has now been extended to an examination of the structure of the films produced by the oxidation of solid metals and alloys, both under conditions of atmospheric exposure and of oxidation at high temperatures. Interesting changes in the structure of these films occur as the temperature is raised, and these changes are of importance in connection with the resistance of the metals to further oxidation and to corrosion. Most of the experimental difficulties in the determination of the solubility of gases in molten metals have now been overcome, and reproducible results can be obtained.

Work on the properties of the light aluminium alloys has been continued, and special attention has been given to the light alloys of magnesium. Certain of these alloys present great difficulties in forging from the cast state, although after the original cast structure has been broken down working can be carried out satisfactorily. These difficulties have been largely overcome by a method of slow pressing at a high temperature. In this way alloys which cannot be rolled satisfactorily may be brought into a condition in which they can be further worked. Special attention is being given to the behaviour of these alloys at high temperatures.

Work on the properties of steels at high temperatures has taken several different directions. Further modifications have been made in the apparatus for the study of the creep of steel at high temperatures *in vacuo*, and good progress has been made with the examination of the method of failure of such specimens under different loads and at various temperatures. The steels used in the research have also been exposed to the action of superheated steam in a high-pressure vessel, and the mechanism of corrosion has been studied.

In the research on the cracking of boiler plates in caustic solution, tests have been carried out with specimens in which a local concentration of stress has been produced by means of notches. The specimens are kept under stress during the whole of the time that they are heated in the high-pressure vessel. Cracking has occurred under such conditions. In another series of tests, one specimen was kept under continuous load, while another was alternately loaded and unloaded.

In the course of the work on gas cylinders for high pressures, attention has been called to the action of carbon monoxide on the steel, considerable quantities of liquid iron carbonyl having been found in some cylinders under these conditions. Some attack on the surface, causing minute flaking, has been found, but no evidence of intercrystalline cracking caused by carbon monoxide has been seen. An examination has been made of several cylinders in which coal gas has been stored under pressure for twelve months or more, with the object of determining the degree of corrosion which may occur under such conditions.

The study of the alloys of iron has been partially in abeyance, and only a short investigation has been carried out on the portions of the iron-manganese system which had not been completely investigated at the time of the publication of the equilibrium diagram. The research on the effect of impurities in copper, reports on which have been issued from time to time during the last eleven years, has been brought temporarily to a close, in order that manufacturers may be given an opportunity of assimilating the results. For this purpose a summary report has been drawn up indicating the principal effect of each impurity alone and in combination with others. Certain commercial ingots were studied in the Department in order to determine whether segregation of impurities was of importance in determining the properties of the metals. The results indicated that segregation in copper does not occur to any serious extent.

Aerodynamics Department.

The second open-jet wind tunnel was completed recently. It is identical in general design with the first and has the same performance. Both tunnels are now in use and their much higher speed has added materially to the research facilities of the Department. The high-speed tunnel working from the exhaust of the Compressed Air Tunnel has been tested, and gave a speed of 975ft. per second with an applied pressure of 60 lb. per square inch. Balances for this tunnel are now being fitted.

Researches in the Compressed Air Tunnel have been continued throughout the year. They comprise mainly a detailed study of the behaviour of six aerofoil sections in common use, and a comparison of tests on a model of a "Parasol" monoplane, using some of these sections, with corresponding results obtained in flight. Tests in the tunnel, using turbulence screens, showed that any effects due to turbulence would be most marked on the maximum lift of aerofoils. Comparisons of maximum lift with full-scale results were therefore first considered, and the excellent agreement so far obtained seems to indicate that the turbulence in the free tunnel is insufficient to cause the results to differ appreciably from those in full-scale flight at the same Reynolds number. The corresponding comparison of minimum wing drag is now engaging attention. In view of the agreement so far found, the aerofoil results obtained in the tunnel have now been published. A number of other tests have been made in the Compressed Air Tunnel, including a study of landing flaps, measurements of the drag of aeroplane bodies, and tests on two models of new aircraft.

Further work on fluid flow has been carried out. The turbulence in a particular system has been explored by the three different methods available, viz., the ultra-microscope, the "hot-dot" method, and the hot wire anemometer, and a reasonable agreement of the three methods has been found. The "hot-dot" method has been further developed, and, in particular, the analysis of its results has been simplified by the use of a photo-electric cell to count the frequency of occurrence of turbulent disturbances of different magnitudes.

The Duplex tunnel has again been used for the development of new designs of aircraft, but there are indications that work of this nature will often be better carried out in the Compressed Air Tunnel, on account of the direct application of results from this tunnel to the full-scale machine without any estimated allowances for scale effect.

Researches on the stability and control of aeroplanes have been continued, and a detailed study is now being made of a particular machine whose full-scale behaviour is known to be very good. The study of stability above the stall has been advanced by the data obtained from experiments on the whirling arm. These experiments show that in stalled flight some of the stability derivatives exhibit very peculiar variations, which could never have been predicted from wind tunnel tests. It is intended to go one stage further on the whirling arm, and to endeavour to make tests with a model having a running airscrew. The work on half-wing models in a wind tunnel has done much to elucidate the effects of different wing tip shapes on stability, and has incidentally led to the development of a new biplane arrangement which may have considerable advantages, particularly as regards controllability at low speeds. Work on spinning has been continued, especially with a view to the provision of data upon the effects of bodies of various cross sections and fitted with various sizes of fin and rudder. This work has shown that body shape is a very important factor in securing safety in spinning.

Much attention has been given to the problem of landing of aircraft. Modern design has led to aircraft of very low drag, which glide in to land at a fine angle and take a long time to lose their speed and come to rest. It has accordingly proved necessary to fit devices, such as flaps, which deliberately spoil the good aerodynamical qualities of the machine when making a landing. As previously mentioned, tests of landing flaps have been made in the compressed air tunnel to provide data. Calculations have been carried out to compare the landing qualities of machines with various devices of this kind, and the enormous saving in landing space which these devices render possible has been clearly established.

The research on high-pitch airscrews has reached a stage at which the experimental results over a very wide range of pitch/diameter ratio can be published. Further work now in hand relates to the tests of certain special airscrews and the comparison of results with the predictions of modern airscrew theory. Comparisons with the most recent theories indicate very good agreement, even at the extreme pitch/diameter ratio of 2·5. These theories are necessarily complicated, but a means has been found, by the use of certain standard charts, whereby they can be applied to the design of airscrews with a minimum amount of labour.

Calculations of the effects of gusts in modifying the loads on aeroplane structures have been continued, and, in particular, attempts have been made to include the effects due to wing elasticity and to the time lag in establishing a new condition of flow over the wings. The greatest need at the moment is for more data on the detailed structure of gusts likely to be encountered, and consideration is being given to the design of instruments for recording such gusts.

Work on flutter during the year has been largely concentrated on a study of the behaviour of flexible models of the "Puss Moth" wings and tail organs, with a view to an explanation of accidents to that aeroplane. This work has involved the construction of elaborate reduced elasticity models and their testing in the tunnel under various conditions. It has led to a more detailed investigation of the effects of solid friction on flutter characteristics, from which some new ideas have emerged, and which has emphasised the desirability of further general work on the oscillations of dynamical systems obeying non-linear laws. The development of methods of solution of oscillation problems by the use of matrices has been further advanced, and a monograph on work of this nature is in course of preparation. The investigation of airscrew flutter has been delayed by the more important flutter work mentioned above, but some further progress has been made.

The William Froude Laboratory.

The main equipment of the William Froude Laboratory has continued to give satisfaction throughout the year, and the new tank has been brought into general use, in particular for the testing of screws in open water and for streamline flow work. The test work carried out on behalf of the shipping industry has remained at high level, and on numerous occasions during the year difficulty has been experienced in satisfying the ugent demands for results.

The opportunities for research work have been rather more limited than in previous years owing to the large demands for tests, but substantial progress has been made on several items. In connection with the work on the influence of waves on the resistance, propulsion and pitching of ships, a paper entitled "Appropriate Ship Lengths for Minimum Pitching and Maximum Seaworthiness" was published early in the year. The research has been continued on three forms of a high-speed twin-screw vessel. In the screw propeller research, further screws have been tested to determine the effect of variation of outline and blade section upon propeller revolutions and efficiency. The applications to both single-screw and twin-screw ships have been studied. A paper dealing with the effect of fins behind a propeller has been read. An investigation has been made of the backing of propellers and the factors which affect the manœuvring of ships ahead and astern. The main research on the manœuvring of ships has temporarily been stopped by the death of the member of the staff chiefly concerned, but the work had reached a point at which it is possible to summarise the effect of rudder proportions on manœuvring and propulsive efficiency. The calculation of the wave resistance of three-dimensional forms has been continued, with particular application to the properties of the bulbous bow. In

the research on the coastal type of vessels, attention has been paid to the use of high-revolution propellers, and the results show the possibility of using high-speed engines in such craft, with the attendant reduction in weight and initial cost.

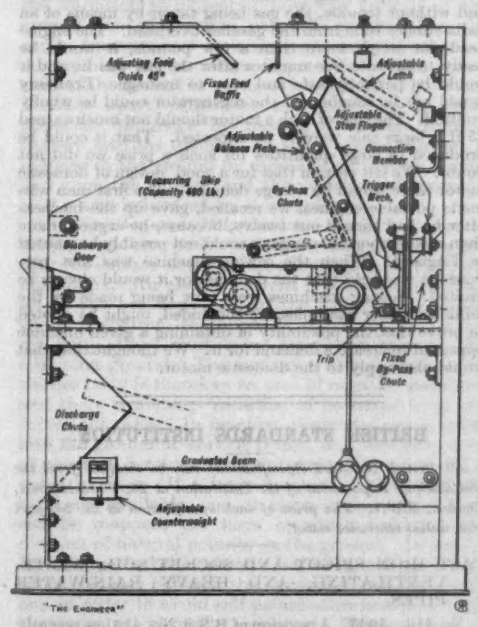
An Aggregate Proportioning Plant.

The increasing stringency of specifications for concrete work has led Messrs. W. G. Jamieson and R. W. Walker, of 49, Kersland-street, Glasgow, W.2, to devise a plant, of which we give an illustration and a drawing, for the precise automatic proportioning of aggregates. The idea is that the rough ballast should be screened to separate out its various sizes and then the several sizes reblended according to the specification for the concrete,

AGGREGATE PROPORTIONING PLANT

any surplus of any size being rejected and not added to the mix. In the case illustrated three sizes are called for.

The machine works according to the weight, not bulk, of the constituents of the aggregate and consequently gives a very exact gradation. The several sizes coming from the screen fall into separate receptacles, each of which is mounted on a shaft supported by a system of levers provided with an adjustable counterweight. The receptacle or skip is so proportioned that when empty it assumes the loading position. Inside the skip there is an adjustable plate, which is set in such a position that just before material sufficient to overcome the counter-

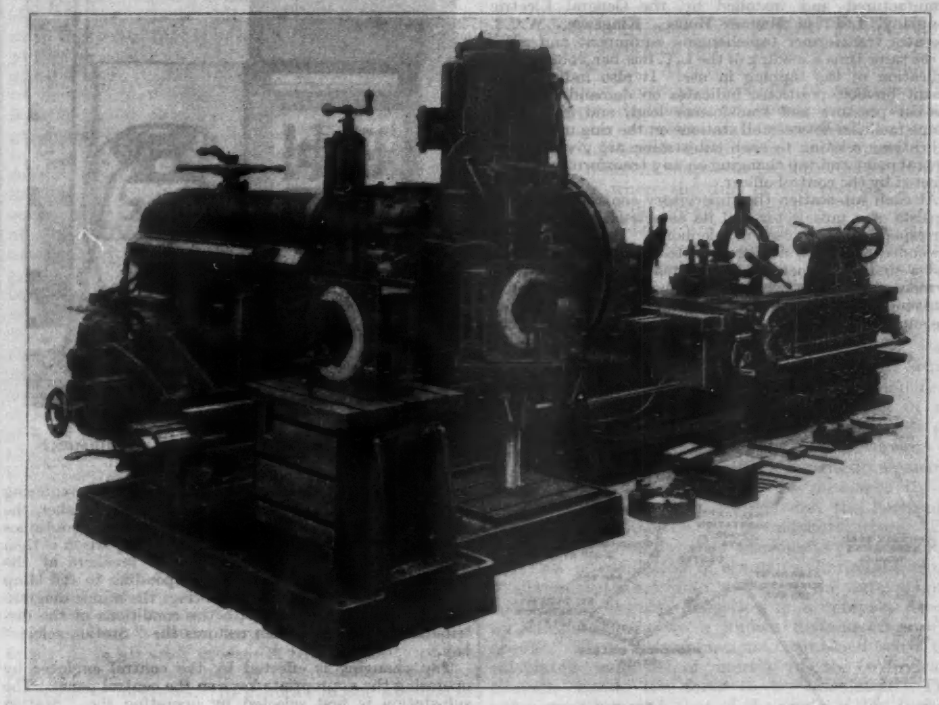


MECHANISM OF PROPORTIONING PLANT

balance weight has been received, the skip will lose its balance and tilt over slightly towards the discharge chute. Further tilting is prevented by a lug, which engages an adjustable latch, but when sufficient material has fallen into the skip to overcome the balanceweight, the skip sinks bodily, the latch is released and as the skip is already out of balance, it tips further forward or is ready to discharge its contents down the chute. The second tilting movement cuts off the supply of material from the screen by bringing a by-pass chute across the feed opening. At the same time a trip carried on the skip travels up the edge of a trigger lever and causes the disengagement of two opposing trigger faces. Discharge is, however, prevented by the trip engaging a stop of the interlocking mechanism. When the trip comes into contact with the stop finger it tends to turn it. This movement is prevented so long as the opposing trigger faces are engaged, the stop fingers being connected together by means of lugs on their axes connected to a common rod. Consequently, until all skips have performed the second tilting movement and disengaged the pairs of opposing trigger faces, no individual stop finger can be turned. So soon as the last skip (which may be any one) receives an actuating load, they all tilt still further and discharge. If desirable, the discharge can be delayed and released by a subsequent process, such as a mixer being re-disposed for loading. The receptacles, when empty, return by gravity to the loading positions, and the interlocking device is repositioned.

Railway Universal Machine Tool.

In an engraving on this page we illustrate a particularly interesting new machine tool made by Kitchen and Wade, Ltd., of Halifax. It has been designed specially for



RAILWAY UNIVERSAL MACHINE TOOL

running or repair sheds where it is necessary to have a fairly full complement of machines to handle expeditiously any kind of repair work which may be suddenly brought in. In principle, it provides a complete machine tool plant for this class of work, comprising, as it does, a lathe, drilling machine and shaping machine, with a hacksaw attachment. All these machines have sufficient capacity to handle the largest axle-box, whilst the lathe can accommodate work up to 8ft. between centres. The principle claim of the makers is that this machine not only takes up less floor space, but is more economical both to run and to purchase than the batch of individual machines it displaces. The drive is by a 10 h.p. motor built in to the head. It supplies power to the whole of the machines, which may be operated simultaneously or individually as desired. Disconnecting clutches are provided so that any one machine can be worked with the others standing.

The lathe has an all-geared head and a large axle-box chuck. This chuck is so arranged that the special jaws can be removed quickly, and four dogs bolted on to form an independent four-jaw chuck of large capacity. In addition, a small recess is provided for mounting a 12in. self-centring chuck, so that the necessity for removing the large chuck is not pressing. A removable half-gap piece is provided as shown in the engraving.

Eighteen spindle speeds from 260 to 6 r.p.m. are available, and three feeds in either direction from 40 to 12 c.p.i. The tool will swing work 18in. diameter over the saddle and 36in. diameter in the gap.

The drilling machine has a capacity up to 1¼in. holes from the solid in steel, being provided with nine spindle speeds from 1440 to 126 r.p.m. and three rates of power feed. The table has two positions for small and medium work, whilst it can be removed to allow large work to be bolted to the base plate.

The shaper is an up-to-date tool with a maximum stroke of 22in. It is coupled to the main drive by a large friction clutch with a brake for immediate stopping. The ram has nine speeds from 93 to 8 cycles per inch, and four rates of feed. The machine admits work 17in. high between tool and table, and the working area of the table is 26in. by 20in.

BOOKS OF REFERENCE.

Planes Directory of the Aviation and Allied Industries, 1935. London: Planes Publishers, Ltd., 4, Johnson's-court, E.C.4. Price 12s. 6d. net.—Practically every trade and industry is now covered by at least one directory, and the publication of a comprehensive reference book for the aviation and allied industries will be welcomed by all connected with them. This book is divided into six sections, each clearly defined by the use of coloured paper. The first section is an alphabetically arranged list of commercial firms connected with aeronautics, engine and aeroplane builders, accessory and component makers, &c. Section II is a comprehensive list of trade names and brands. Section III contains the names of commercial and private aircraft owners registered at the Air Ministry, flying clubs, flying schools, airports, and aerodromes throughout Great Britain. The classified trades are dealt with in Section IV, and overseas and foreign countries' aerodromes, constructors, &c., are covered in Section V. The volume ends with a chapter of general information. We are informed that this book has been produced as a private venture, and there is no doubt that the two years spent in compiling it have been well spent, for we feel sure that it will be of definite value to all interested in the aeronautical and allied industries.

The Official Year Book of the Scientific and Learned Societies of Great Britain and Ireland. London: Charles Griffin and Co., Ltd., 42, Drury-lane, W.C.2. Price 10s. net.—The fifty-first annual issue of this reference book contains, as hitherto, full up-to-date particulars of all the scientific and learned societies in the British Isles, with a record of their publications issued during the session 1933–34.

CATALOGUES.

J. and E. Hall, Ltd., Dartford.—Publication No. 733, on escalators manufactured by the firm under licence from Carl Flohr A.G., of Berlin.

Bruce Peebles and Co., Ltd., Edinburgh, 5.—Specification No. 161, giving the salient features in the construction of "Peebles" transformers.

Nissen Buildings, Ltd., Rye House, Hoddesdon, Herts.—Booklets illustrating the Nissen steel buildings and showing examples of structural steelwork.

Evershed and Vignoles, Ltd., Acton-lane Works, Chiswick, W.4.—Publication No. 177, dealing in detail with distant indication and control for water undertakings.

Westinghouse Brake and Saxby Signal Company, Ltd., 82, York-road, N.1.—Descriptive pamphlet No. D.P. 41 of the firm's new air pressure servo for road vehicle brakes.

English Electric Company, Ltd., Queen's House, Kingsway, W.C.2.—A new publication on 150 to 3500 b.h.p. heavy-oil engines. Publication No. R 46 on metal-clad switchgear.

Switchgear and Cowans, Ltd., Elsinore-road, Old Trafford, Manchester, 16.—Catalogue Section 23 on the single bus-bar, metal-clad, compound-filled internal isolation switchgear.

Babcock and Wilcox, Ltd., Babcock House, Farringdon-street, E.C.4.—A brochure illustrating and describing the firm's special process equipment and some of their products.

National Gas and Oil Engine Company, Ltd., Ashton-under-Lyne.—Publication No. 206, describing reverse-reduction gears for National marine engines and in particular the oil-operated type.

Specialloid, Ltd., Friern Park, N.12.—The firm's new piston catalogue and directory, which illustrates the various types of pistons it makes and giving lists of the engines to which the pistons may be fitted.

James Gordon and Co., Ltd., Regent House, Kingsway, W.C.2.—Catalogue H.13, on Hagan automatic boiler control, and Pamphlet A.3, dealing with the thermostatic high and low-water-level alarm and distance indicator.

United Steel Companies, Ltd., 17, Westbourne-road, Sheffield, 10.—"Some Notes on Alloy Steels," a booklet giving briefly the development of the various steel-making processes and the application of some of the alloy steels.

Stewarts and Lloyds, Ltd., Kings Buildings, Dean Stanley-street, S.W.1.—Catalogue Section "O," dealing with oil country tubular goods. This is primarily an abridgment of the latest editions of the A.P.I. Specifications 5–A and 5–L, giving the essential details in a concise form. The tables appended give the complete particulars of the standard oil pipes and joints. In addition, particulars are given of Stewarts' welded joints of both taper sleeve and spherical types; also of Victaulic joints and of Johnson couplings.

A Remote Supervisory Control System.

A RECENT example of the application of remote supervisory control to an electricity supply network is to be found on the A.C. distribution system of the Winchester Corporation Electricity Department. A ring main encircles the city, as indicated in Fig. 1, and 33-kV grid feeders from the Central Board's sub-station at Nursling feed the St. Cross sub-station, which supplies the 11-kV network from two 2000-kVA transformers, while in the sub-stations on the ring main the pressure is reduced to 400 and 200 volts.

The ring main is divided into two parts, known as the east and west sections, and the switching arrangements enable the two portions to be fed individually or as one complete ring, according to conditions; while the sub-stations may be disconnected without breaking the continuity of the main. Protective gear is interconnected between the sub-stations by a pilot cable which also carries the four pilot wires for the operation of the supervisory control apparatus. The control is centralised at the power station and the supervisory equipment, which was manufactured and installed by the General Electric Company, Ltd., of Magnet House, Kingsway, W.C.2, operates transformer tap-changing equipment and gives at the same time a reading of the L.T. bus-bar volts and an indication of the tapping in use. It also indicates oil circuit breaker positions, indicates on demand the L.T. bus-bar pressure and transformer load, and gives telephone facilities between all stations on the ring main. The indications relating to each sub-station are given at the central point and tap changing on any transformer may be effected by the control officer.

At each sub-station the supervisory control equipment consists of a uniselector and its associated relays, which correspond to those used in telephony. They are fitted in a wooden case with a hinged lid to facilitiate inspection, and a similar cabinet accommodates the metering transformers and relays, whilst a telephone is mounted in a convenient position, as shown in Fig. 2. Current for both the supervisory equipment and the circuit breaker tripping

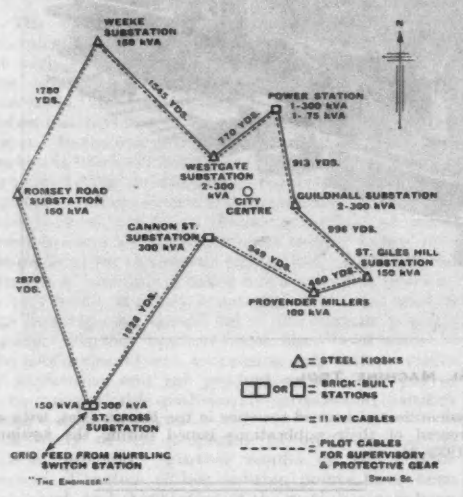


FIG. 1—11-KV DISTRIBUTION NETWORK, WINCHESTER

mechanism is supplied by a 30-volt 20-ampère hour storage battery, trickle charged from the supply. With the exception of the telephone all the apparatus at the control station is fitted inside the control cubicle, shown in Fig. 3. Each of the panels on the front of the cubicle is associated with a sub-station and carries rotary keys representing the circuit breakers at the sub-stations and lever keys designated "Station select," "Voltmeter," "Ammeter," "Tap raise," and "Tap lower." Adjacent to each key there is an associated lamp, whilst at the top of each panel there is a large red station lamp. The knobs of the rotary keys are designed to form part of a diagram painted on the panels to represent the H.T. ring main, L.T. bus-bars, and switching arrangements, the positioning of the panels being in accordance with the geographical lay-out given in Fig. 1. A notable feature of the equipment is that future developments of the distribution system can readily be catered for. Each sub-station panel on the control cubicle is complete in itself and is jacked in on the mounting and secured in position by four fixing screws. As there are four spare panel positions, in the event of a sub-station being added to the network the necessary addtional apparatus at the control point is easily added by jacking in a further panel equipped with the necessary keys and lamps, while the additional sub-station is linked up for supervisory control merely by extending the pilot wires. An ammeter and voltmeter, transformer tap indicator, and various keys are mounted above the sub-station panels on the control cubicle. The control station telephone set is inside a noise-proof cabinet, while a klaxon horn for giving the calling signal is placed outside. A 50-volt 25-ampère hour battery, trickle charged from the mains, supplies current for the operation of the supervisory control apparatus at the control point.

The lamps do not glow continuously, but light up individually when an indication is given, thus ensuring that they have a long life and that the current consumption is reduced to a minimum. As under normal conditions the sub-stations are unattended, it is important that automatic changes in breaker positions should be made known to the control engineer without delay. As, moreover, manual operation of the circuit breakers is carried out by an attendant who visits the sub-stations under instructions, it has been necessary to provide means for assuring the control engineer that his instructions have been adhered to. Any change of the condition of sub-station switchgear is consequently immediately signalled to the control point. When a circuit breaker has been operated, either automatically or manually, the control engineer's attention is drawn to the control cubicle by a loud-ringing bell, while the glowing of the red lamp on the particular sub-station panel indicates that a change is to be signalled from that sub-station.

The engineer therefore operates the "Station select" key on that panel, with the result that the lamp is extinguished and the calling sub-station is connected to the control point in readiness for the indication. The connection is effected on a selection system. It is carried out automatically by the control apparatus, and when the operation is complete a check on the correctness of the selection is given and the station lamp glows. The apparatus then automatically compares the position of each circuit breaker at the selected station with the position of

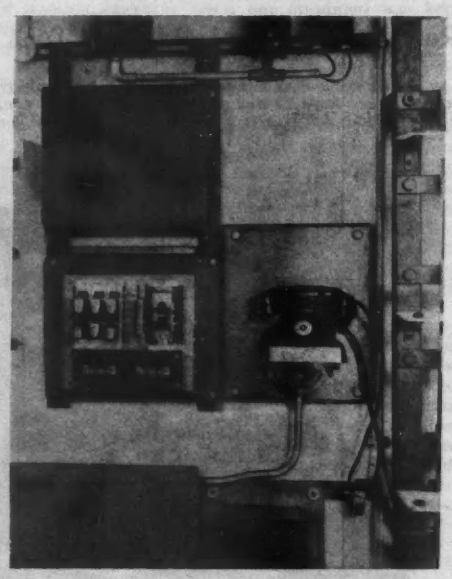


FIG. 2—SUPERVISORY CONTROL EQUIPMENT

the rotary key on the control panel and, on encountering the discrepancy due to the operation of the breaker, the lamp adjacent to the appropriate key lights and continues to glow until the key is changed. The comparison is then automatically continued until all the breakers at the station have been checked. By responding to the lamp indications the control engineer brings the mimic diagram into complete agreement with the conditions of the distribution system and then restores the "Station select" key.

Tap changing is effected by the control engineer by operating the appropriate keys on the control panel. The sub-station is first selected by operating the "Station select" key, when the station lamp glows to indicate the correct selection. The "Tap raise" or "Tap lower" key is then operated as desired to cause an appropriate contactor at the sub-station to be selected in readiness for

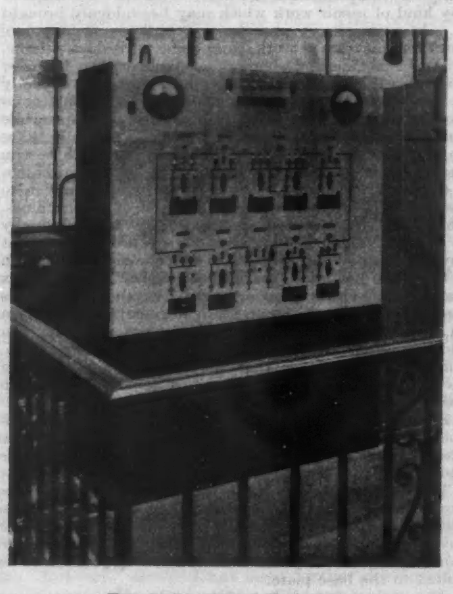


FIG. 3—CONTROL CUBICLE

operation. When the key is operated the lamp adjacent to it glows, thus indicating that the supervisory equipment has made the correct selection at the sub-station. On depressing a key marked "Operate" on the top panel of the control cubicle the contactor at the sub-station is made to operate and to cause the tap-changing switch to move one step. At the same time the effect of the change is indicated on the voltmeter, which, on restoring the key to its normal position, is disconnected and a numeral on a glass screen is illuminated from behind to indicate the position of the tap switch. If the voltage is not of the desired value the "Operate" key is depressed again to make the switch take another step and to cause the voltmeter to give another reading. The bus-bar volts or the load on a transformer may be read at any time on the appropriate meter. Selection of any particular sub-station is made by means of the "Station select" key and a "Voltmeter" or "Ammeter" key is then depressed as required. The station lamp glows and the lamp adjacent to the key operated lights to indicate correct selection. When this condition obtains a key adjacent to the meter is operated to connect the meter in circuit and the required reading may then be taken.

By providing telephone communication over the pilot wires full co-ordination of the stations is completed. At the control point the telephone is fitted with an automatic dial to enable any sub-station to be called by dialling an allotted number after a key on the instrument has been operated, whilst any sub-station may call the control point by operating a key on the telephone set. After a reply is received the key at the calling station is restored and it releases the supervisory control apparatus, which is then free to indicate any change which may occur on the system. Telephone conversation over the pilots does not in any way affect indications of switchgear changes.

The application of the equipment to the scheme described is one of many possible applications. On water supply systems, sewage works, electrical power distribution systems, &c., centralised control has made considerable progress, for, apart from maintaining continuous service, it leads to reduced operating costs. For permission to describe the Winchester scheme we are indebted to Mr. R. Ayton, the City Electrical Engineer and Manager.

SIXTY YEARS AGO.

WHO would supply a want long felt, and give the world a really good domestic motor, an engine of some kind which would drive any or all of the machines now common in almost every household? To the discussion of this question we addressed ourselves in a leading article in our issue of May 14th 1875. Attempts had already been made to produce a small apparatus that would drive a sewing machine, a knife cleaner, or a washing machine but they had met with little success. We laid it down that the ideal domestic motor must be free from risk of explosion or fire, be generally applicable, unlikely to get out of order, easy to control and manage, cleanly and cheap. Any scheme based on the winding up of springs or weights could be dismissed on the ground that the labour spent on winding would be better spent directly on the machines to be driven. Surveying the field open we considered the use of water power, of steam, hot air, gas or petroleum engines, and of electricity. We were favourably attracted by the hydraulic motor operated by the domestic water supply but we considered that in London and most large cities sufficient water was not available to drive numerous domestic turbines of about one-fifth horse-power each. Small steam engines with little vertical boilers heated by Bunsen burners were at the moment of writing being introduced for domestic use but we criticised them from the point of view of safety and because of the heat and smell accompanying their employment. Electricity we dismissed in three lines as being too costly, delicate and troublesome to satisfy the requirements. Of petroleum engines too little was known at present, we said, for anyone to pronounce an opinion on their suitability for the purpose in view. The gas engine might possibly be developed to suit domestic use. We foresaw no difficulty in constructing little engines of the Lenoir pattern which might be elegant in design, simple and easily managed. To the hot air engine, however, we extended our chief favour. Hitherto hot air engines had not been successful but their failure had arisen from causes which would hardly operate under domestic conditions. It ought, we said, to be possible to produce a little hot air engine which would drive a sewing machine or other apparatus silently and without trouble, the gas being taken by means of an india-rubber tube from the gasalier overhead. The engine need not weigh more than a few pounds, it would be ready to operate five minutes after the gas was lit and it would be perfectly safe and easy to manage. Economy would not be sought and the regenerator could be wholly omitted. The cost of such a motor should not much exceed £5 if a large sale were to be expected. That it could be produced in large quantities for such a price we did not doubt. We felt certain that for a good design of domestic motor there would be a large demand. The first man who made portable engines, we recalled, gave up the business after he had turned out twelve, because, he argued, more than a dozen portable engines could not possibly be wanted in England. When the sewing machine was first produced it was held that the demand for it would always be limited. Sewing machines were now being made by the million. Other examples, we concluded, might be quoted to prove that the possibility of obtaining a given machine appeared to create a demand for it. We thought that that would also apply to the domestic motor.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

CAST IRON SPIGOT AND SOCKET SOIL, WASTE, VENTILATING, AND HEAVY RAIN-WATER PIPES.

No. 416—1935. A revision of B.S.S. No. 416 has recently been issued. Since the publication of the 1931 issue of the specification it has from time to time been found necessary to issue addendum sheets to the specification. These sheets have provided for the following additions:—(*a*) A clause on marking; (*b*) a table of dimensions for equal double branches (branch gradient 135 deg.); (*c*) a table of dimensions for unequal double branches (branch gradient 135 deg.). The present revision has therefore been effected to embody these additions in the specification, together with the inclusion of an additional table for the dimensions of 2in., 2½in., and 3in. short radius bends, without access doors. One other major alteration in the present revision is the rearrangement of the classification of pipes according to weight. The terms "extra heavy grade," "heavy grade," and "medium grade" are now definitely related to pipes of ¼in., $^{13}/_{64}$in., and $^{5}/_{16}$in. thick respectively.

Practical or Applied Geophysics.*

PRACTICAL or Applied Geophysics is concerned with discovering what lies beneath the surface of the earth in a particular place without incurring the expense of making a direct test by boring, shaft sinking or tunnelling.

In some places materials of economic importance occur in considerable masses at accessible depths. These may differ from the adjoining parts of the crust in being heavier or lighter, having a higher or lower conductivity, in being magnetic, or in having different elastic properties. For one or more than one of these reasons it may be possible to detect such a mass by observations at the surface of the ground. In other cases, substances which are sought for on account of their economic value are found by previous experience to be associated with certain arrangements of the strata in the outer crust; in other words, with what geologists call a geological structure such as an anticline, a syncline, a fault, or an intrusion of igneous rocks. In an anticline lower strata are brought nearest the surface along its crest, and if these strata differ in density, elasticity, electrical conductivity, or magnetic permeability from those that occur on the flanks of the anticline, such differences can by appropriate means be detected at the surface of the ground. Similarly, a fault, which is a complete severance of the strata, usually brings in apposition on the two sides of the fault plane rocks of different characters, which difference can again usually be detected. If the geological structure is exposed at the surface, any geologist can discover it for himself by inspection or by mapping and the use of geophysical methods is unnecessary in such cases. It may often happen, however, that the structure in the rocks is concealed beneath a superficial cover of considerable thickness, such, for example, as glacial deposits, alluvial deposits, old lake deposits, water bodies, or a layer of rocks of later geological date than those in which the particular structure to be investigated occurs. It is in such cases that geophysical methods are applied. The particular method employed depends upon the object of the investigation. In some cases only one method stands much chance of success; in other cases the same mass or structure is discoverable by more than one means, and one then serves as a useful check on another.

The geophysical methods that have been utilised so far fall into certain categories:—

(1) Electric.
(2) Magnetic.
(3) Gravimetric.
(4) Seismic.
(5) Other categories.

Electrical Methods.

The electrical methods of geophysical prospecting fall into two main types:—(*a*) That of determining the variation of potential near the surface of the ground due to currents naturally produced in the earth (spontaneous polarisation), and (*b*) that of determining the variation of potential or the resistance of the ground in between two points at a certain distance apart which are maintained at a given potential difference by passing a current from a battery into the ground. In some cases a current is induced in the ground by means of an electric circuit laid upon the surface, and the variation of potential in the area influenced by it is explored.

(*a*) *Spontaneous Polarisation.*—In some circumstances an ore body undergoes chemical changes near the surface as the result of oxidation by circulating waters. An electric current is in consequence set up in the ore body and in the surrounding rocks, which flows from the upper to the lower end of the ore body, the circuit being completed through the adjoining ground. The surface of the ground above the ore body is therefore an area of negative potential and there is a sharp variation of potential from the centre outwards. In practice, electrodes are inserted into the ground at various points, and the differences of potential between them determined by means of a potentiometer. If a large number of such observations are available, one or more equipotential lines can be mapped, the form of which indicates the position of natural polarity in the ground. In applying this method the operator has to ensure good electrical contacts between the electrodes and the earth, and in order to avoid self-polarisation non-polarising electrodes are normally employed. These consist of copper rods which dip into porous pots filled with a solution of copper sulphate. The pots are inserted into shallow holes made in the surface and thoroughly wetted if the ground is dry. Since the form of the equipotential lines is also governed by the varying conductivity of the ground itself, it is obvious that the results obtained have to be interpreted with caution. The method would be of little use in exploring unknown country, and it has relatively limited applications.

(*b*) *Exploring Currents.*—In the majority of electrical investigations current is passed into the ground by means of two electrodes placed at a given distance apart (current electrodes), and the nature of the ground between them is explored by means of two, or in some cases three, other electrodes (potential electrodes) inserted into the ground at determined points. The difference of potential between these and the current passing between them can be measured by a potentiometer and a milliammeter. It is usually arranged that the distance between these exploring electrodes, which is referred to as the electrode separation, is the same as that between them and the nearest current electrode, so that the four points are arranged at equal distances. The theory of the method is based on Maxwell's theory of electro-static images. It is important to bear in mind, however, that the theory is founded on certain precise assumptions, namely, that the conductivity of each layer is uniform, and that the media extend to an infinite distance around the current source. Now the materials that form the surface of the ground may vary greatly in their resistivities according to local conditions. A sandstone normally is highly resistive, but if it is waterlogged, or, still more, if its pores are filled with saline water, its resistivity is enormously lowered. Accordingly, if the resistivities of a sandstone area were examined along a profile extending from a valley over a neighbouring hill the resistivity would rise towards the higher ground and fall towards the valley, because the water table there is nearer the surface. Again, a limestone is normally highly resistant, but if, as frequently happens, it contains cavities full of water its resistance may be greatly lowered. Hence such changes of resistivity as may be encountered in a given profile are capable of a variety of explanations. If the geology of the area is known in considerable detail beforehand, changes in resistivity can usually be accounted for, but in such cases the geophysical investigations reveal little, if anything, that was not already known. In some cases, however, an examination of an area of known geological characteristics can be made the basis for an investigation in an adjoining area where they are not so well known, and some information with regard to that area may be obtained which may help to extend the geological data. It is a process of extrapolation, as it were, from a known to an unknown area; as in all such processes, the reliability of the interpretation diminishes as the distance from the known area increases. In general, in the absence of some geological information in advance of an electrical prospection the interpretation of the results would carry little conviction. A highly conductive layer at the surface masks to a large extent the behaviour of a more resistant layer below.

Prospecting by various earth-resistivity methods has been carried on for many years and undoubtedly very large sums have been expended in such investigations. The difficulty lies in the interpretation of the measurements when they have been obtained. It is clear that when this method was applied in the earlier years the interpretations were empirical, and later investigations of the physical principles underlying the method have shown many of them to have been based on erroneous notions. It would appear that, in the scramble for results, commercial prospecting far outstripped the study of physical principles and the collection of data relating to the various types of rocks whose properties controlled the results. Even now there appears to be a great lack of accurate data relating to the specific resistivity of various classes of rocks under different conditions. This especially applies to the porosity of various rock types, and the effect of the degree of saturation and the nature or hydrogen-ion concentration of the liquid which occupies the pore spaces.

It seems clear from the results that have been published in more recent years that prospectors feel more and more the need for fundamental investigations by physicists and mathematicians, and there seems also to be a more general tendency to publish the data necessary to allow a judgment to be formed of the success or otherwise of the method as applied to particular problems. It is probable that for certain types of inquiry electrical methods are likely to offer the best chances of success. The probability of success cannot but be increased as the study of physical principles is extended and the collection of fundamental data improved.

Magnetic Methods.

On the surface of the earth there is a magnetic field due to the earth, which, for any time and place, is relatively constant in direction and strength. The vertical plane in which the force lies is that in which a magnetic needle freely suspended will set itself, and is known as the magnetic meridian. If an accurately balanced magnetic needle is suspended on a horizontal pivot it will be found to dip below the horizontal plane by an amount which varies as the needle is turned round a vertical axis. When the needle is set at right angles to the magnetic meridian it remains horizontal, but as it is turned its dip increases and reaches a maximum when the needle lies in a plane parallel to the magnetic meridian.

In most parts of the earth at the present time the magnetic meridian does not coincide with the geographical meridian; the difference is called the declination (d). The amount by which the needle dips below the horizontal plane is called the inclination or dip. The direction in which the needle points is that of the magnetic field at the locality, and may be considered to be resolved into a horizontal and a vertical component. If the horizontal component be H, the vertical component V, and the resultant force R, then:

$$R^2 = V^2 + H^2;$$

the dip is determined by the relative values of V and H, such that if i is the angle of dip,

$$\text{Tan } i = \frac{V}{H}.$$

d and i and the forces R, V, and H are referred to as the magnetic elements. The normal earth's magnetic field at any one locality is found to vary in three different ways: (1) A slow change, called the secular variation; (2) a rapid change, called the diurnal variation, and (3) irregular changes, called magnetic storms. At any one time the direction and force change from one locality to another. The lines of equal declination are determined periodically by magnetic surveys and represented on maps by lines of equal declination or isogonic lines. Similarly, different maps can be constructed showing those places where the dips or the vertical or horizontal or resultant forces are equal.

In addition, there are restricted localities on the earth's surface where the magnetic elements differ markedly from their values in the surrounding region. Such departures from normal conditions are termed magnetic anomalies, and it is these anomalies that are usually investigated by geophysical prospectors. They are due to the presence at some distance below the surface of either material which behaves as a permanent magnet (like magnetised steel) or material which becomes magnetic in the earth's field (like soft iron). These anomalies are investigated by the same types of instruments as are employed in determining the magnetic elements.

The inclination or dip may be measured by an instrument called the dip-circle and the horizontal force and declination by a magnetometer. The earth's horizontal force is obtained by determining the time of oscillation of a small cylindrical magnet in the magnetic meridian, and using the same magnet to cause an angular deflection of a compass needle by bringing it up to a known distance from the needle. These determinations, combined with the calculated moment of inertia of the cylindrical magnet, enable the force to be calculated. This value, together with that of the angle of dip, furnish the vertical force and the resultant. Other types of these instruments are employed for measuring, not the actual intensity of the force, but the variations in that intensity as compared with a nearby region which is taken as the standard. Such instruments are called magnetic variometers, and are particularly serviceable in exploring magnetic anomalies. Vertical or horizontal variometers or both may be employed. The horizontal or vertical magnetic force can also be determined by rotating a coil in the earth's field and measuring the induced current by means of a galvanometer or a microammeter.

Magnetic methods are particularly serviceable in detecting the presence of, and locating, bodies of iron ore, though in special cases geological structures can be detected by reason of some of the rocks which enter into them exhibiting magnetic properties in greater or lesser degree.

The applications of magnetic methods of geophysical surveying are fairly straightforward, and have been of great use in exploring some of the immense masses of iron ore, such as that of Kiiruunavaara, in Sweden. Other applications are to the location of mineral veins, which may be associated with iron ores either as primary constituents or as secondary products. Masses of igneous rocks can, in some cases, be discovered by reason of their content of magnetite; some igneous rocks are so strongly magnetic that compass readings are wholly unreliable in their neighbourhood.

Gravimetric Methods.

If a unit mass is brought up from infinity to the earth's surface the work done in traversing the gravitational field is the gravitational potential. In a level part of the earth's surface, where gravity is uniform over a considerable area, surfaces of equal gravitational potential would be parallel to one another and to the surface of the ground. The value of gravity at a point is inversely proportional to the vertical distance between adjoining equipotential surfaces. If, however, a mass of high density occurs at or near the surface an equipotential surface would be raised to a higher level above the mass than in the surrounding area. There would thus be a variation in the value and direction of gravity in the neighbourhood of the mass, and it is such variation that is made use of in gravitational methods of geophysical exploration. The difference in the gravitational field may be due to the presence of material of high density over a limited area, such as a mass of iron ore or of igneous rock, or it may be due to a

* From the Forty-First James Forrest Lecture, by Professor Owen Thomas Jones, F.R.S., Inst. Civil Engineers, May 7th, 1935. Readers who are interested in the instruments referred to by Professor Jones are referred to a series of articles on "Geophysics" in our issues of July 31st, August 7th and 14th, 21st and 28th, 1931.

geological structure, such as an anticline, whereby dense rocks are brought nearer to the surface along the crest of the anticline than along its flanks. In some cases the matter that is brought up in this way is lighter than the surrounding strata, as in the case of salt domes, which are often found associated with oil. Again, a disturbance of the gravitational field may be caused by a fault which brings into apposition two rock masses of different densities.

Cavendish employed an instrument for determining local gravitational attraction, and later Baron Eötvos designed the instrument called after him, the Eötvos balance. This differs essentially from the Cavendish type, in that only one of the masses is attached at the end of the horizontal rod ; the other is suspended from the opposite end by a fine wire. In the Eötvos balance the masses are about 25 grammes each, the horizontal rod is about 40 cm. in length, and the wire suspending the second mass is about 60 cm. In another type one of the masses is carried on a vertical rod above one end of the horizontal bar, and the other is attached by a similar rod below the other end. This is known as the Schweydar or "Z" type of torsional balance, the cross bar of the "Z" being, however, in the horizontal plane. In some types a similar set of masses at right angles to the first set is included. In a third type, usually termed a Gradiometer, designed by Shaw and Lancaster Jones in 1927, two equal masses are carried on the circumference of a light wheel about 10 cm. in diameter. A third similar mass is attached to the end of a light rod which projects upwards from the wheel at a point equidistant from the other masses. The wheel is suspended, as in the original Cavendish apparatus, by a fine wire which is attached to spokes meeting at its centre. If the torsion balance is set up in an area where gravity varies from one place to another the masses lie on different equipotential surfaces, and one of the masses is subjected to a greater horizontal pull than the other, so that the system is affected by a couple which causes it to rotate until the couple is balanced by the torsion of the suspending wire. The characteristics of the wire are supplied by the makers, or can be determined independently. The deflections are read on a scale set at a known distance from a mirror carried at the centre of the system. Inasmuch as the position which the torsion balance system would assume in the absence of local attraction cannot be determined directly, readings of the instrument are taken in different azimuths differing by 60 deg. or 120 deg., according to the type of instrument. In general the deflections are recorded photographically. If the undeflected reading be supposed to be n, and n_{θ}, n_{120}, and n_{240} be the scale readings in three azimuths, then

$$n_{\theta}-n+n_{120}-n+n_{240}-n=0 \text{ or } n=\frac{n_{\theta}+n_{120}+n_{240}}{3}.$$

The deflection is due to the difference in the rate of change of gravity in one plane, say, north-south, and in the plane at right angles, or to the gradients of gravity in these directions.

Suppose we represent the variation of gravity near the centre of the instrument and in the direction of the east-west axis by F, and that in the direction of the north-south axis by G, then the resultant variation R is related to the components along the axes by the relation $R^2=F^2+G^2$. This is termed the horizontal gradient (or rate of change) of gravity, and its direction is given by the angle φ measured, say, from the north-south meridian by the relation $\tan \varphi=\frac{F}{G}$.

If the variation of gravity around a point is not uniform it can be represented by a curved surface, in which the curvature in one direction is a maximum and in the direction at right angles a minimum. The torsion balance readings enable this curvature to be calculated both in amount and direction. The curvature is sometimes more serviceable in the interpretation of the effects than the gravity gradient ; in most investigations both curvature and gradient are determined.

The instruments are of extraordinary sensitiveness ; a change in gravity of one million millionth part of its total value can be detected, and since gravity is nearly 1000 cm./sec.^{2} it follows that a change in the force of attraction on a mass of 1 gramme of the order of 1×10^{-9} c.g.s. units can be detected. This is called an Eötvos and is the unit usually adopted in gravimetric investigations. If a vertical dyke of rock of density 3·5 occurred in the ground at a depth of 100ft. below a uniform surface, it has been calculated that it would cause a gradient of 13 units and could therefore be detected easily.†

In applying the method in practice many factors have to be taken into account. The surface of the ground is not in general uniform ; elevations large and small, walls, buildings, ditches, or even trees exert an influence on the instrument which tends to mask the underground effect which it is sought to discover. Accordingly corrections have to be applied for all such surface features as are within a certain distance of the instrument. The effects of topographical irregularities have to be calculated for distances of 1000ft. from the station, and if there is any considerable relief the estimation must be carried to even greater distances. In addition, if there is reason to suspect marked irregularity in the nature of the ground or terrain near the station that also has to be allowed for. It is the calculation of the corrections to be made for surface variations that makes the method laborious in the field. The authors of the Report on the Imperial Geophysical Experimental Survey estimated that a tree 2ft. in diameter at a distance of 10ft. from the station where the instrument was set up would cause a gradient of about 2 E‡.

When the readings of the instrument have been taken, and corrections of various kinds have been applied, the values of the horizontal gradients of gravity in two azimuths are obtained and the resultant plotted as a vector, oriented in the direction of the gradient, whose length is proportional to the value.

Then arises the question of interpretation. In some simple cases this presents little difficulty, provided there already exists some knowledge of the geology of the region ; in other cases, however, similar results might be derived from a variety of causes.

There is no doubt, however, that the torsion balance is an instrument of the greatest service in those types of investigation where masses occur below the surface which differ in density from their surroundings.

The gravitational method has been used successfully for tracing faults and buried river channels, and for locating masses of igneous rocks or pockets of hematite, such as occur in the carboniferous limestone of Cumberland and north-west Lancashire.

Seismic Methods.

Seismic methods make use of charges of high explosives fired at a depth of a few feet below the ground for producing artificial earthquakes in accordance with the suggestion made by Mallet. The explosion sets up longitudinal, transverse, and surface waves. The times of arrival of the waves at a chosen point on the surface are recorded by means of an instrument called a seismometer or seismograph. In general, the seismometer used in prospecting consists of a heavy mass, which on account of its inertia does not immediately respond to the movement of the ground. The case or box in which it is contained is, however, immediately affected, so that there is a differential motion between the inertia mass and the case. By suitable devices the movement is recorded on a magnified scale on a moving strip of paper or photographic film driven by clockwork or by a descending weight. Small time intervals are also continuously recorded on the same strip. The moment of the explosion is indicated on the time scale by the breaking of an electric circuit. The time interval between the origin of a shock and the arrival of the first or (theoretically) any other pulse can be determined on the record with considerable accuracy. The particular method employed for a seismic survey depends on the type of problem which it is desired to investigate.

The mass waves set up by the explosion travel downward in the crust, and if the strata are uniform they arrive at increasing distances from the shot point at equal intervals of time. In general, however, any rock is more compact at a depth than at the surface. Consequently the velocity of propagation increases downwards ; the paths of the waves are accordingly cruved so as to be concave upwards. The first impulse recorded on the seismogram is that which has travelled by the fastest route. If, however, there happens to be a marked difference in the strata at a certain depth below the surface, a wave travels with different speeds in the upper and lower layers. The contact between two such layers is referred to as a surface of discontinuity. Let us suppose that it is a level plane and that waves travel faster in the lower layer than in the upper. An elastic wave meeting such a surface is analogous to a ray of light impinging upon the boundary between two media of different refractive indices. A part of the wave is reflected and a part is refracted into the lower stratum. The reflected wave reaches the surface in a time which depends upon the path which the fastest wave ray has taken and on the velocity in the upper stratum. The refracted wave travels in the lower stratum, and, passing upwards through the boundary, arrives at the seismograph at a different time.

If the velocity in the upper stratum is uniform in a horizontal direction, the shortest path for the reflected ray is that which makes the angle of reflection equal to the angle of incidence at the boundary. In the case of the refracted ray the relative velocities in the two strata probably determine the angle of incidence of the fastest ray, which is such that the ray is refracted at the critical angle and travels in the lower stratum along the boundary. According to the distance between the seismograph and the shot point, the refracted wave may arrive before or after the reflected wave. It is not, of course, known that this is the real path of the refracted wave, since its time of arrival would be the same if the wave from the explosion passed vertically down and up through the upper stratum with the velocity appropriate to that material, and with the greater velocity in the lower stratum in between. As the distance increases the refracted wave arrives first, and, from a comparison of the times of arrival with varying distances, it is possible to make an estimate of the depth to the boundary and of the velocities in the two strata.

Some geophysicist make use of the refracted waves, others prefer the reflected wave, for the reason, it is said, that records can be obtained with smaller charges of explosives. In "refraction shooting" several seismographs are ordinarily used, which may be arranged in a straight line or fanwise ("fan shooting"), according to the nature of the problem. If the object is to obtain the depth to a given surface, the straight-line method is often most convenient. If the surface has a decided slope the profile is shot in both directions, which enables the depth as well as the approximate amount of inclination of the surface to be calculated. Fan shooting is convenient where a structure such as a salt dome is sought for. Waves travel with a considerably greater velocity in the salt than in the sedimentary rocks with which it is associated in these structures. If therefore the seismographs are arranged fanwise and the speed in some directions is found to be distinctly greater than in others, it is inferred that those waves have passed through the dome, and its margins can in this manner be roughly outlined. By repeating the tests from different points a closer estimate of the size and outline of the structure can be made. It may be noted that a plug or dome of some types of igneous rock might give identical results, so that the seismic method cannot prove that salt is present, and not some other material.

Both the refraction and the reflection methods allow the depth to a given surface to be determined. In practice, various uncertainties arise. There may be more than one surface of discontinuity in the strata ; the refracted wave may therefore have penetrated through several different strata before emerging at the surface. The records are then capable of more than one interpretation. In general, the reflection method may reveal several such surfaces, and if the velocities in the different strata were known the depths of these surfaces could be determined readily. If the geological section has already been determined in the region in a bore-hole or a shaft, then it is, in general, possible to discover which stratum is responsible for a given reflection, and the depth to one or more of these surfaces can be obtained in other parts of the area, thus extending the geological data.

These methods are of particular service, for instance, in mapping oil-bearing formations, which are frequently associated with a structure such as an anticline. If the oil formation is situated either above or below a band of hard rock, the depth to that rock at various points can be determined by seismic methods. The rock surface can therefore be contoured and the structure clearly demonstrated.

Such methods appear to be admirably adapted for determining the depth to the surface of the old rocks underlying the newer rocks in the eastern half of England, which is now only known from bore-holes at widely separated places. There is no doubt that elastic waves would travel in these rocks with much higher velocities than in the overlying Mesozoic cover. If the refraction method were employed it might be possible to form some idea of the nature of the old rocks, and even of the direction of their strike. It would be a great geophysical achievement if it were possible to construct even a rough map of these old rocks, which are buried to a depth of 1000ft. to 2000ft. beneath newer strata.

† Imperial Geophysical Experimental Survey, p. 138.

‡ *Ibid.*, p. 317.

Russian Oil Engine Trial Results.—With reference to the report published under the above heading in the "Seven-Day Journal" of April 5th, we have been informed by M.A.N., Ltd., of London, that only four engines were entered by them for these trials, not eight as stated.

Drill Container.—We have received from Fry's (London), Ltd., 24/25, King-street, London E.1 a sample of a new drill container which they are placing on the market. The container is made of wood and holds eight twist drills from $^{1}/_{16}$in. to $^{9}/_{32}$in. diameter. The top is rotatable and may be turned to permit any one of the eight drills to fall out through a hole in it. In one position the top retains all the drills within the body. The container should prove useful to many classes of user as a means not only of protecting their drills from damage but of finding the required size of drill expeditiously.

The Institution of Mining and Metallurgy.—Nearly 250 members and their guests were present at the annual dinner of the Institute of Mining and Metallurgy, which took place on Thursday, May 9th, at Grosvenor House, Park-lane. The entire proceedings conveyed a spirit of optimism and the tone of all the speeches was one of gratification for the success of the past year and a hopeful outlook for the future. The chair was taken by the President of the Institution, Sir Harold Carpenter, F.R.S. The toast of "The Institute of Mining and Metallurgy" was proposed by Mr. Francis Phillips, who paid a tribute to the members of the Institution who had succeeded in making in the last few years such great technical strides in the field of precious metal mining, both in South Africa and in other places. The prosperity of recent years had enabled the gold-mining industry to take advantage of all the latest developments of science and to encourage research. In his acknowledgment of the toast, Sir Harold Carpenter agreed with Mr. Phillips' remarks, adding that the healthy state of the mining industry was proved by a glance at the list of members seeking positions on which the number of names had decreased to one-quarter the number in 1930. He paid tribute to the generosity of the mining companies to the Institution, and to the research work done by them. Finally, Sir Harold expressed his thanks to Mr. A. J. Brett, the Vice-President, and to the staff of the Institution, for their unfailing co-operation with him during his term of office. Mr. Carl R. Davis, the President-Elect, then proposed the health of "Our Guests," paying particular tribute to the assistance received by the mining profession from the Governments of South Africa and the High Commissioner of Rhodesia, who was present. The toast was acknowledged by Sir Frank E. Smith, Secretary for the Department of Scientific Research, who reminded those present that whereas it had been said that nothing had been done in this civilisation that had not been done in the past, yet the truth was far away from this, as seen by the fact that this country alone could support a population to-day so much in excess of the population of six or seven million that it had supported in the past. He expressed his admiration for the work done by the metallurgist in making this progress possible. The toast of "The President" was then proposed by Sir Auckland Geddes in a short speech which acknowledged Sir Harold Carpenter's work of the year.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Some Effects of the Steel Pact.

Since the Jubilee celebrations business generally in the iron and steel markets has definitely improved. No doubt the removal of the uncertainty which resulted from the Anglo-Continental pact has had a great deal to do with the recovery, although the task of arranging a long-term agreement remains to be accomplished. Neither the British nor the Continental makers have lost any time in getting to grips with their problem. Directly the three-monthly arrangement had been decided upon, meetings of the Cartel were held on the Continent, and on this side similar steps were taken. Sectional committees have been appointed to discuss details regarding imports of the various descriptions of steel included in the total, and this week meetings of representatives of the British Iron and Steel Federation and the Cartel have been held in London. In the meantime, the Continental steel makers for the most part have declined to quote prices for the British market, but this has not inflicted much hardship, since merchants have been able to fill the gap by selling against old contracts they had with foreign works. Export business has been only partially checked, but the severe competition for orders in some of the overseas markets appears to be a thing of the past. The Continent still quotes special prices for markets like India and China, but these are a few shillings per ton higher than those which ruled immediately before the agreement was reached with the British makers. It is in the home market that the expansion in business has occurred, since export trade is still lethargic. Apparently buyers had held up orders until the future course of events in the iron and steel trades could be more clearly discerned, and are now placing orders with considerable freedom.

British Iron and Steel Production.

In its monthly report for April, the British Iron and Steel Federation state that pig iron production amounted to 526,300 tons, against 554,200 tons in March and 496,300 tons in April, 1934. The April output includes 122,700 tons of hematite, 266,900 tons of basic, 120,500 tons of foundry, and 8300 tons of forge pig iron. The production of steel ingots and castings totalled 808,700 tons, against 841,900 tons in March and 716,800 tons in April of last year. In making comparison with the March figures, allowance must be made for the shorter working month and the Easter holidays. There were ninety-six furnaces in blast at the end of April, three having been blown out for repairs and relining and one having started production. The report does not give particulars, but of the three blown out two were at the works of Gjers Mills and Co., Ltd., Middlesbrough, and one at the Holwell Works of the Stanton Ironworks Company, Ltd., at Melton Mowbray. The furnace blown in was at the Workington branch of United Steel Companies, Ltd. The following table shows the average monthly production of pig iron and steel over a period of years, and the output for the past four months :—

	Pig iron, tons.	Steel, tons,
1913—Monthly average ..	855,000	638,600
1920 ,, ,, ..	669,500	755,600
1929 ,, ,, ..	632,400	803,000
1932 ,, ,, ..	297,800	438,500
1933 ,, ,, ..	344,700	585,300
1934 ,, ,, ..	498,200	738,300
1935—January	521,200	757,800
February	483,100	769,500
March	554,200	841,900
April	526,300	808,700

Pig Iron.

After a long spell of rather quiet markets a somewhat better tone is noticeable in the pig iron trade. A feature of the position is the scarcity of basic pig iron. The production of this description is on a good scale and is well over 50 per cent. of the country's output. Nevertheless, so strong has been the demand from the steel works that this has not been sufficient. The shortage has been particularly noticeable on the North-East Coast, and two furnaces which have been producing foundry iron for some time have been turned over to basic. This has left only two on foundry in that district, and the production has not been more than sufficient to provide for the deliveries against existing contracts. As a result stocks are being drawn upon, and it is perhaps a good thing that a fair tonnage accumulated over the Easter holidays. Business in Midland brands of pig iron has been rather dull, but since the holidays there have been signs of an increased demand. One of the satisfactory features of the situation is the expansion in the requirements of the light castings industry. The improvement is only moderate, but it is a movement which has been long delayed, and suppliers of pig iron anticipate that it will develop the more quickly for that reason. Consumers, however, show no inclination to buy forward, and in some cases expiring contracts have not been renewed. It is known that considerable stocks of pig iron exist in the Midlands, particularly of Derbyshire foundry iron, and in these circumstances buyers feel that there is little likelihood of an increase in prices for some time. In Scotland there is a steady demand for local brands, whilst considerable tonnages of English iron are also reaching the Scottish market. Nevertheless, the output of the Scottish furnaces seems to be passing into consumption, or, at any rate, the additions to stock are negligible. There has been a revival in interest in hematite pig iron, and negotiations have been opened for contracts extending over the second half of the year. At the same time, consumers are in no hurry to close business, as they are convinced that if prices are not likely to fall this year they are not likely to advance.

Scotland and the North.

The prospects for the Scottish steel trade were seldom better than at present. Not only have most of the works sufficient orders in hand to keep them running for two or three months at the present rate, but the limitation by agreement of the imports of Continental steel and the probability of an improvement in export business through a similar arrangement have given a cheerful tone to the market. The requirements of the shipyards are on an impressive scale, although there will be a sharp decline in the output of shipbuilding steel if fresh orders for ships are not soon received. This is the weak feature of the position, and the inquiries now in circulation are disappointing. At any rate, it is not anticipated that the slackening in the demand for shipbuilding material will seriously affect the works until the second half of the year. There is a good outlet for railway material, although some contracts in this department are approaching completion. The re-rolling industry is better employed than for some time, but is not in full operation. It is expected, however, that the Anglo-Continental agreement will result in more work in the shape of orders for strip and small bars. In the Lancashire market steady conditions rule. Deliveries are on a satisfactory scale, and there is a fair amount of new business about. The disinclination of consumers to contract forward is rather irritating to the steel makers. The demand for most light steel products, including small sections, bars and hoops, is active, and most of the re-rolling concerns have secured a fair amount of new business recently. Some complaints are heard of the poor demand for plates, including boiler plates; but, on the other hand, the heavy engineering industry is fairly well employed and is providing a good outlet for this description of steel. The constructional engineers have worked off a number of contracts of late, and for the time being the demand is inclined to be quiet. In the Barrow district the works have sufficient orders on their books to keep them well employed for the next month or two. Both at Barrow and at Workington a good tonnage of rails, billets, bars, slabs, and hoops is being rolled.

The Midlands and South Wales.

The agreement with the Continent and the subsequent reduction in the steel duties have not stimulated business in steel in the Midland markets to any marked extent. Production, however, is at a high rate and the demand for joists and sections has been particularly active. At the same time, business has been made up chiefly of small parcels, as the constructional engineers do not seem inclined to book far forward. Some of the steel makers report that they have filled their programmes for some little time ahead, and it is understood that less structural steel is now going into stock to meet future calls. There is a tendency on the part of some consumers to hold aloof from the market until the situation which has been brought about by the Anglo-Continental agreement can be gauged. The re-rolling mills are better employed now than at any time this year, the demand for bars and strip being particularly brisk. The bookings improved during the period when the higher range of duties ruled, although imports of Continental material against old contracts continued. The non-associated works quote well below the official Association prices, and at the moment theirs are the lowest quotations in the market, since no Continental material has been offered this week. Business in plates has not been satisfactory, but some improvement is noticeable in the market for sheets. The producers of billets report that the volume of new business has declined, but they have booked heavily during the past few weeks and specifications are coming forward freely. Business in sheet bars, however, has been rather subdued, in spite of the rather improved situation at the sheet mills. The collieries continue to take fair quantities of steel, but this trade is now approaching the season when the demand usually declines. There have been no price changes, arches being quoted at £8 for light and £8 15s. for heavy sections, including accessories. Business in roofing bars has been erratic and the quotation varies from £6 7s. 6d. to £7 2s. 6d. d/d. The situation in the market in South Wales does not deteriorate, although, on the other hand, it shows few signs of improving. Business in most products has run on quiet but steady lines. The state of limited activity ruling in the tin-plate trade, of course, has affected most other branches of the industry in South Wales. There is hope of the position changing for the better at the end of June, when the first year of the international tin-plate scheme expires, and some readjustment of the quota excesses and deficits is probable. Recently the home market for tin-plates was brought under control, and an arrangement made to regulate delivered prices. The home quotation has now been advanced from 17s. 9d. basis, f.o.t., to 17s. 10½d.

Current Business.

A reconstructed blast-furnace was blown in by Colvilles, Ltd., at the Clyde Ironworks, Tollcross, Glasgow, on May 4th. It has a productive capacity of 2000 tons per week. The furnace and its auxiliary plant has cost more than £100,000. A contract for the supply of ten cranes for the Lyttelton Harbour Board, New Zealand, has been secured by the Clyde Crane and Engineering Company, Ltd., Northend, Lanarkshire. The Greenock Dockyard Company, Ltd., has obtained a contract for a cargo steamer of 10,500 tons d.w., for use in the British-Australia trade, from the Scottish Shire Line. The Austin Motor Company, Ltd., of Birmingham, has placed contracts in connection with an expansion scheme for increasing the scope of the press and dispatch shops totalling £50,000. British Timken, Ltd., of Aston, Birmingham, have secured an order for eighty-eight complete roller-bearing axle-boxes for fitting to locomotives and coaches of the Entre Rios Railways, Argentina. Orders have also been obtained for four complete axle-boxes for the Kiao Chow-Tsinan Railway, China, and for eighty bearings for the Belgian State Railways. It is reported that part of the plant, including the 8in. and 10in. mills, of the Motherwell Iron and Steel Company, Ltd., which was recently sold for dismantling, will be shipped to India. The Import Duties Advisory Committee have given notice of an application for an increase in the import duty on wrought iron and steel tubes and pipes. The Tata Iron and Steel Company, Ltd., have placed a contract valued at over £500,000 with Simon-Carves, Ltd., of Cheadle Heath, Manchester, for a complete by-product coking plant to be built at their steel works. The Department of Overseas Trade reports that the following contracts are open for tender :—Chilean Ministry of National Defence : Supply and installation of three electric travelling portal cranes (Santiago, June 24th). Wellington : Posts and Telegraphs Department : 5000 metal-cased condensers of 1 mfd. capacity (Wellington, July 1st); Public Works Department : 11,000-volt indoor switchgear and control equipment for Section 375 of the Arapuni Power Development (Wellington, August 13th). City of Port Elizabeth, South Africa : Supply, delivery, and erection of a 5 million gallons per day purification plant near the Linton reservoir (Port Elizabeth, August 22nd). Egypt, Ministry of the Interior : Material for electrical installations at Bardis and Baliana, H.T. and L.T. transmission lines, telephone lines, cables, distribution pillars, transformers, &c. (Cairo, July 18th).

Copper and Tin.

The activity in the electrolytic copper market has been well maintained, and prices have steadily advanced over the greater part of this week. Buying has been general, and lately some of the Continental Governments have bought substantial quantities. It may be, of course, that the buying departments are anxious to cover national requirements as fully as possible while the metal is comparatively cheap, but naturally the market, always sensitive on this point, regards the purchases as being primarily for munition purposes. During this month the copper producers' restriction plan is only partially in operation, and the cut in production is not more than 20 per cent. In fact, it is possible that even this limit is not strictly observed; but it is understood that the scheme will be firmly administered after June 1st and that the cut will then be 25 per cent., in which case its influence upon supplies should be noticeable within the course of a few weeks. Prices in the London standard copper market have also improved, and although there has been profit taking upon a large scale, the quantities offered on the market have been easily absorbed either by newly opened bull accounts, or by hedging operations by merchants against sales of electrolytic copper to consumers. It is noticeable that less electrolytic copper is reaching the standard market, and when the restriction scheme comes into force it is anticipated that such sales will cease entirely. . . . Following the incident last week when dealers walked out of the tin market as a protest against the withholding of supplies from would-be buyers, quiet conditions have ruled. There is still a shortage of prompt tin, and for this interests associated with the control and the Buffer Pool are blamed. It is argued with some force that the Buffer Pool was instituted to release tin on the market under just such circumstances as now prevail, but so far there has been little sign that the protest has had any effect upon those responsible for holding up the metal. The backwardation has now increased to over £7, and this, of course, prevents the use of the market for legitimate hedging operations, whilst the artificial control exercised over the market restricts speculation. In the United States a Bill has been introduced into the House of Representatives which proposes an excise tax of 6c. per lb. upon metallic tin imported into the United States, when the domestic output equals 1500 tons yearly, to organise prospecting in America for tin deposits, and to subsidise research for substitutes for the metal.

Lead and Spelter.

An improvement has taken place in the demand for lead as a result of larger Continental requirements. For a long time the consumption of lead in Great Britain has been on a heavy scale, whilst the reverse has been the case in the principal lead-using countries in Europe. Lately, however, Continental buying has expanded, and it is possible that as a result less foreign lead will be shipped to Great Britain. In fact, the arrivals this month are expected to be less than usual. On the London market there has been a certain amount of profit taking by speculators and, at times, this has slowed down the upward movement in prices. Owing to the smaller arrivals this month the contango has disappeared, and the prompt and forward prices have been level. It is suggested that the higher price of silver will result in a larger output of lead, as the precious metal is often found in lead ores. In that case, the maintenance of current prices would depend upon whether consumption expanded in proportion to the higher production. . . . In sympathy with the better tone of the lead market and in the non-ferrous metal markets generally, spelter prices have improved over the week. Continental buying has been partly responsible, but there seems to have been a better demand from consumers in all countries than for many weeks past. Some Continental spelter has arrived in this country, and further shipments are expected before the end of the month. As a consequence, the contango has narrowed to 2s. 6d. and may disappear towards the end of May. A feature of the position is the good demand for zinc sheets, which is keeping the British makers busily engaged.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. Coast—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 8 6	3 2 0
No. 1	3 9 0	3 2 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 7 6	—
Midlands—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 12 6	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 6	—
Scotland—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 7 6	—
N.W. Coast—		
Hematite Mixed Nos.	3 12 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
Lancs.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. Yorks.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
Midlands—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	7 5 0 to 7 15 0	—
Scotland—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. Coast—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
London and the South—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	8 5 0
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 7 6	7 15 0 to 8 5 0

STEEL (*continued*).

	Home.	Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 0 0	8 15 0
14-G. to 20-G., d/d	10 5 0	9 0 0
21-G. to 24-G., d/d	10 10 0	9 5 0
25-G. to 27-G., d/d	11 2 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £16 12s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.

20 by 14 basis, f.o.b. Bristol Channel Ports, 12/2 to 19/2.

Tin-plate Bars, d/d South Wales Works, £5 7s. 6d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 tons	5 15 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 10 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·70 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/– to 5/3d. per lb.	

NON-FERROUS METALS.

Official Prices, May 15th.

Copper—		
Cash	£33 8 9 to £33 10 0	
Three months	£33 17 6 to £33 18 9	
Electrolytic	£37 0 0 to £37 5 0	
Best Selected Ingots, d/d Birmingham	£37 10 0	
Sheets, Hot Rolled	£64 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
Brass—		
Ingots, 70/30, d/d Birmingham	£28 0 0 to £30 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9¼d.	9¼d.
„ Brazed	11¼d.	11¼d.
Tin—		
Cash	£226 15 0 to £227 0 0	
Three months	£219 5 0 to £219 10 0	
Lead: Cash and forward	£14 0 0	
Spelter	£14 15 0 to £14 18 9	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

Lanarkshire—	Export.
f.o.b. Grangemouth—Navigation Uncreened	13/– to 13/6
„ Glasgow—Ell	15/6 to 16/6
„ „ Splint	17/6
Ayrshire—	
(f.o.b. Ports)—Steam	14/– to 14/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	13/6
Unscreened Navigation	12/9 to 13/–
Lothians—	
(f.o.b. Leith)—Hartley Prime	13/6
Secondary Steam	12/– to 12/6

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	15/– to 16/–
Northumberland, Newcastle—	
Blyth Best	13/9 to 14/–
„ Second	13/3
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 13/6
Durham—	
Best Gas	14/6
Foundry Coke	19/– to 20/–

Sheffield—	Inland.
Best Hand-picked Branch	24/– to 26/–
South Yorkshire Best	21/– to 23/–
South Yorkshire Seconds	17/6 to 19/–
Rough Slacks	8/– to 9/–
Nutty Slacks	7/– to 8/6

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	24/– to 37/6
Furnace Coke	19/– to 21/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	41/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 22/6
Rubbly Culm	11/– to 11/6
Steam Coals:	
Large	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Industrial Situation.

FROM whatever angle the situation of the engineering industries is viewed it is clear that any recovery depends upon financial and currency adjustments and that without such adjustments trade must continue to go from bad to worse. There is provision for expenditure on military defence and public works but these latter have been slowed down by the difficulty of procuring funds in the present state of the national finances, and all other sources of industrial activity are arrested by lack of private enterprise through the general trade depression. In Paris, traders have, for the first time, openly appealed for a devaluation of the franc as a means of extricating them from their difficulties, but the Chambers of Commerce and other bodies insist upon the maintenance of the gold standard, urging that the real solution of the problem lies in reducing taxation on industry and effecting further economies in national expenditure. Attempts at retrenchment have not kept pace with the dwindling national revenue. The only encouraging feature of the situation is the weekly decline in unemployment figures, which, however, is partly explained by an increasing departure of foreign workers, so that the figures are less impressive than they are made to appear. An example of the difficulties that have to be overcome is afforded by the report of the Chambre Syndicale des Industries Métallurgiques du Rhône, which states that the number of men employed in the metallurgical district around Lyons fell by nearly 38 per cent. in the four years ending December last, and that since the beginning of the present year the decline accelerated to the extent that, amongst the ninety-four members of the Chambre Syndicale, the fall by the end of March was nearly 40 per cent. and the number of hours worked declined by more than 47 per cent. The Chambre Syndicale objects to legislation for restricting the hours of labour as a means of reducing unemployment, which, it says, can only be attained by providing more work, and that is only possible by relieving industry of taxation and reducing national expenditure. Meanwhile there is a strong agitation for putting more public works in hand, and Monsieur Le Trocquer, Senator and former Minister of Public Works, again pleads for a vast programme of national work to be undertaken by means of a national loan. All these palliatives are admittedly unsatisfactory and will do nothing to bring about a return to industrial activity, which is only possible when the gold, sterling, and dollar countries are able to settle upon currency stabilisation.

The Steel Negotiations.

Negotiations between the British Steel Makers' Association and the Continental Cartel were resumed last week-end in Paris and will be continued as long as is necessary, during the three months' truce, to arrive at a settlement. The meeting is reported to have revealed a sincere desire on both sides to find an acceptable compromise. How desirable it is for French steel makers to stabilise the industry is seen in the figures of production in France during March, issued by the Comité des Forges, from which it appears that the steel output was 503,000 tons, as compared with 528,000 tons in the corresponding month of 1934, while the production of pig iron totalled 482,000 tons, as against 526,000 tons. Some idea of the actual capacity for production may be gathered from the fact that the average monthly output in 1913, including Alsace-Lorraine, was 581,000 tons of raw steel and 756,000 tons of pig iron. Since that time the capacity for production has been notably increased, so that the competitive possibilities are now greater than ever before. The difficulties of French steel makers are aggravated by their higher monetary values, which make them extremely desirous to keep the Cartel alive, particularly since the devaluation of the belga.

Improved Electric Lighting.

Conferences on the art of illumination organised during the past week by the Société des Architectes coincided with a communication by Monsieur André Claude on the practical uses of the rare atmospheric gases krypton and xenon for lighting, and presented to the Académie des Sciences by Monsieur Georges Claude. These gases allow of a tungsten filament being brought to a higher temperature without fusing than is possible in a lamp containing argon, and the light is consequently whiter, and the better efficiency of lamps with krypton or xenon is shown by the reduced heat radiation. Experimental lamps filled with one or other of these gases leave no doubt in the mind of Monsieur Georges Claude that they represent a great advance in the quality of electric lighting. The problem is to produce the gas on a commercial scale, which Monsieur Claude believes is perfectly practicable by installing liquid air plants exclusively for that purpose.

The "Normandie."

In her trials over the measured mile off Penmarch the "Normandie" fulfilled expectations by attaining a speed of 31·7 knots, and her behaviour during the various runs is said to have been all that could be desired. The liner has arrived at Havre, where celebrations will be held on board until she leaves on the 29th inst. for New York. Already almost the entire accommodation has been reserved in view of the attraction offered by the maiden voyage.

Railway Electrification.

The electrification of the Paris-Orleans line from Paris to Vierzon has now been extended to Brive, and the new section was inaugurated on Wednesday last, so that the length of the electrified line is increased to 312 miles. This transformation will allow of a notable speeding up of train services, and it is hoped to reduce the time between Paris and Vierzon by an hour by exceeding the legal maximum of 74 miles, the non-observance of which is regarded with tolerance in such circumstances. Simultaneously with the railway electrification, work has been continued on the hydro-electric supply, and it is expected that the Marèges power station will be put into service during July.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

SWITCHGEAR.

426,100. April 13th, 1934.—ELECTRIC MOTOR CONTROLLERS, *Igranic Electric Company, Ltd.*, 147, *Queen Victoria-street, London, E.C.*4.

This controller system is specially applicable to motors which have to be reversed frequently and quickly, such as those driving the chains of feeder catcher tables of tin-plate mills. There are two squirrel-cage motors A A connected with a three-phase supply through the reversing switches B B B, which are operated by the coils C C. In the motor leads there are reactances D D D, which include de-energising windings E E E. These windings are supplied with direct current through a relay F, operated by the series winding G in the main motor circuit. The reactance coils are marked H. The series relay F is normally open, and thus when the motors are started from rest by closure of either of the reversing switches, the coils E are disconnected from the direct-current lines, whereby the motors at the instant of starting are subjected to the maximum reactance of coils H. On the other hand, assuming appropriate design and adjustment of the series relay, the initial inrush of current to the motors will cause the relay F to respond to connect the coils E to the D.C. supply circuit, and these coils will thereupon act gradually to reduce the reactance value of coils H for smooth acceleration of the motors. The motors in accelerating will effect reduction of the current supplied thereto, and again assuming appropriate design and adjustment of the series relay, it will release to disconnect the coils E when the

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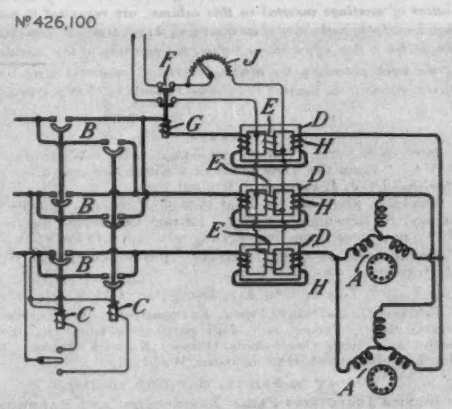

motors have accelerated to a given degree. Disconnection of these coils, of course, tends to increase the reactance, but with the series relay properly designed and adjusted such increase may be delayed until the motors attain a speed reducing the motor current to such a value that the voltage drop across the reactor coils will be small and unobjectionable. Thus the reactors will be restored to a condition affording maximum reactance value thereof shortly after starting of the motors, and if thereafter the reversing switches are operated for plugging of the motors, the reactors will function first to control deceleration, and then to control reacceleration of the motors. More specifically, when plugging is initiated the reactors will provide a maximum reactance, whereas the increase in value of the current of the motor circuit incident to plugging will cause the series relay again to respond to reconnect the D.C. coils, thereby affecting gradual decrease in reactance for deceleration and re-acceleration of the motors. After the motors are thus reversed and reaccelerated, the series relay will again release to disconnect the coils E, thereby again preparing the reactors to function either upon restarting the motors from rest or upon plugging of the motors. As will be apparent, the reactors are adjustable by the rheostat J, which may be located at the mill control stand and thus the rheostat affords means whereby the mill attendant watching movement of the plates may readily adjust the controller to meet different operating conditions, and thereby minimise chance of slipping, &c.—*March 27th*, 1935.

426,127. July 28th, 1933.—ELECTRIC OVERLOAD RELEASE MECHANISMS, P. Branchu, 6, Rue du Dr. Laurent, Paris XIII.

In this breaker the circuit to be interrupted forms the coil round the laminated core B, and produces an intense field A

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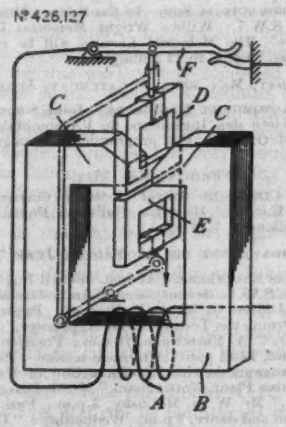

between the poles C C. Two metallic rings D and E are suspended between the poles and the currents induced in them by the magnetic field make the rings repel one another. The rings are connected with the moving contact F of the breaker in such a way that they act in unison to open it in the event of an excessive current passing.—*March 28th*, 1935.

TRANSFORMERS AND CONVERTERS.

426,147. December 18th, 1933.—METAL-CLAD ELECTRIC ARC CONVERTERS, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, and E. Gallizia.

This invention relates to metal-clad electric arc converters of the kind using liquid cathodes, and particularly to means for insulating the cathodes from the main parts of the chambers of the converters, an object being the provision of a vacuum-tight seal which in use will deteriorate little, if at all, which reliably insulates the cathode, and which is such that the electrical connection to the cathode may be effected in a simple manner. The vessel A of metal containing the cathode pool B of mercury is provided with a central pin or terminal C

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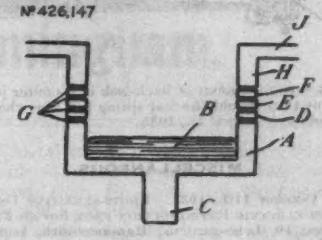

extending downwardly from its lower surface. This pin or terminal C is used for connecting the cathode B in the external circuit. Above the vessel A and coaxial therewith, three relatively thin metal rings D E F are provided, each insulated from the other and the bottom one D from the vessel by coatings of enamel G and each of the same diameter and radial width as the walls of the vessel. Above these three rings a fourth metal ring H is provided which is coaxial with the other rings, and the walls of the vessel and of the same diameter and radial width as the other rings. The ring H is thicker and is formed with a radial flange J. This ring H is similarly separated by enamel from the thin top ring F.—*March 28th*, 1935.

MEASURING AND TESTING INSTRUMENTS.

426,279. December 5th, 1933.—MEASURING LENGTHS OF ROLLED MATERIAL, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.*2.

The apparatus is intended to measure the length of such objects as rails or bars as they are delivered from a rolling mill. The object is marked A and is passed over the live rollers B B, one of these, C, is recessed and within the recess there is arranged

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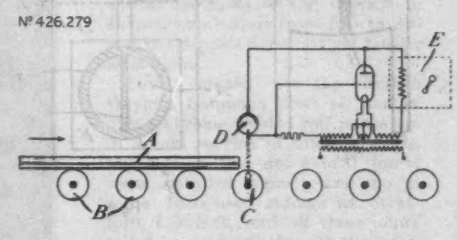

an electric light. This light shines on the photo-electric cell D so long as the rail or other object does not intervene. The photo-electric cell is connected through an amplifier with the relay E, which is interconnected with a revolution counter on the shaft of the roller C. The number of revolutions of the roller C during which the beam of light is obscured is then a measure of the length of the rail or other object.—*April 1st*, 1935.

MACHINE TOOLS AND SHOP APPLIANCES.

426,294. April 10th, 1934.—MACHINE FEED SCREWS, V. Jereczek, Wolframstrasse 8, Berlin-Tempelhof, Germany.

This arrangement of feed screws for machine tool carriages prevents backlash if the screw threads or the nuts wear. Two feed screws A and B are provided with threads of opposite hand. They are geared together by the helical toothed wheels C and D. The end reaction of these wheels causes the two screws to bear

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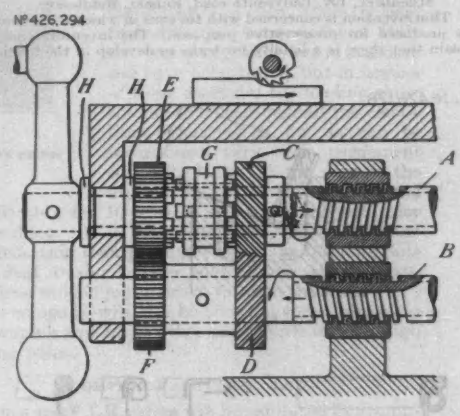

up against their nuts in opposite directions and take up any play. As it is desirable to have free movement for the return of the machine table, the two screws are also intergeared by straight toothed wheels E and F. Either of the wheels C or E can be connected with the driving spindle by the clutch G. The screw A is positioned by the thrust collars H H.—*April 1st*, 1935.

MOTOR CARS AND ROAD TRAFFIC.

426,287. January 26th, 1934.—SPRINGING OF FRONT WHEELS, Daimler-Benz Aktiengesellschaft, Stuttgart-Untertürkheim, Germany.

This design of front wheel arrangement is intended to relieve the frame of a motor car of racking stresses, as much as is possible, when the wheels ride over an uneven surface. The front wheels are mounted on stub axles A, which are part of the bracket B. The bracket swivels for the purpose of steering on the pin C. At the top this pin has a ball head to engage the lever D. This lever is pivoted to the car frame at E, and is supported by the spring F. At the bottom the pin C is attached,

in a non-rotative manner, to the leaf spring G, which is bolted to the chassis near its centre line. A shock absorber is provided at H, and is connected with the axle bracket by an arm J

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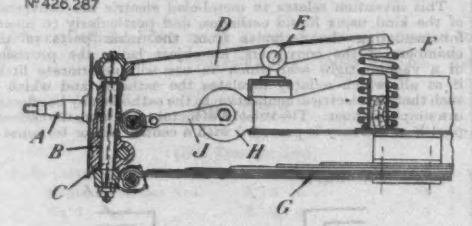

that has a certain amount of back-lash in its outer joint. It is pointed out that should the leaf spring fail, the wheel will not entirely collapse.—*April 1st*, 1935.

MISCELLANEOUS.

426,126. October 11th, 1933.—Light-sensitive Devices for Photo-electric Reproduction from Sound Films, C. G. Lemon, 19, Lena-gardens, Hammersmith, London, W.6, and L. Kecskemeti, 1, Cygnet House, Kings-road, Chelsea, London, S.W.

This invention relates to a light-sensitive device for reproducing photographic sound records, and has for its object to provide an improved light-sensitive device in which the light-sensitive surface is made in the form of a narrow band or line, so that by placing the sensitive surface very close to the sound record the usual narrow aperture or light slit can be dispensed with. According to the invention, a light-sensitive device of the kind in which the light-sensitive material is disposed between the edges of metal electrodes separated from one another by a thin layer of insulating material is provided, wherein the electrodes are made in the form of segments of a cylinder and

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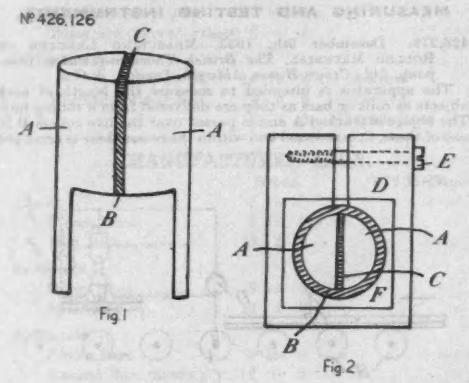

assembled to form a complete cylinder, the light sensitive material being applied between the linear edges of the segments at one end of the cylinder. The cell shown in Fig. 1 is of the "condenser" type, but employs only two semi-cylindrical metal electrodes A A, separated by insulating material B, and connected along two parallel edges by a layer of light-sensitive material C, which forms a continuous narrow band or line. The width of this line should be not greater than that of the aperture or slit normally employed in known sound reproducers, in which such an aperture or slit is placed in close proximity to the film. The complete cell is of cylindrical form, the sensitive material C extending across the flat end thereof as shown, and is held in a clamp or holder D fitted with a clamping screw E, as shown in Fig. 2. The clamp or holder D is preferably also equipped with a transparent cover F for protecting the light sensitive material.—*March 28th*, 1935.

426,128. August 25th, 1933.—Tin Cans, T. Clarkson, 5, St-John's Church-road, Hackney, London, E.9, and A. L. Stuchbery, 107, Ladysmith-road, Enfield, Middlesex.

This invention is concerned with tin cans in which a vacuum is produced for preservative purposes. The inventors complain that there is a liabilty for leaks to develop in the longi-

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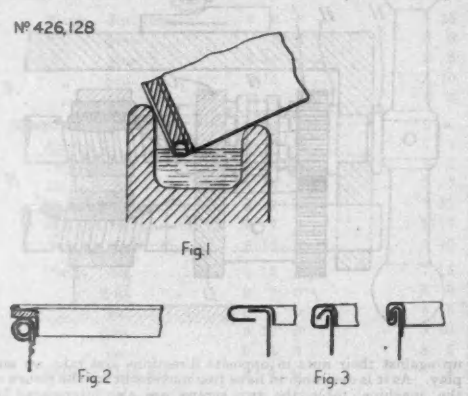

tudinal side seam where it is beaded over to form the curled edge on which the lid is seated. As a consequence, they solder the edge of the can by rolling it along in a bath of solder, as shown in Fig. 1. The solder then only extends over the part that is likely to be damaged. The sketches, Figs. 2 and 3, show a method of reinforcing the edge with a collar.—*March 25th*, 1935.

426,139. September 30th, 1933.—Ventilators, J. L. Musgrave, 43, Bloomsbury-square, London, W.C.1, and Richard Crittall and Co., Ltd.

This invention relates to a new device for use in connection with the ventilating of buildings. The device consists of a hollow trunk at the upper end of which a plurality of flat plates or discs, spaced one above the other, are supported. The lowermost plate or disc, which fits around the upper end of the trunk, is slightly larger in diameter than the external diameter of the trunk, the diameter of each succeeding plate or disc increasing from the lowermost upwards. In each of the discs or plates, below the uppermost plate or disc, a central opening is formed. The size of the opening in the lowermost plate corresponds or nearly corresponds to the internal diameter of the trunk, and the opening in each succeeding disc or plate decreases in diameter, thus forming a gradually decreasing passage from the trunk or body to the underside of the uppermost disc or plate. The trunk is divided longitudinally into four passages or air shafts by two thin partitions fitting therein at right angles to one another. These partitions are formed at the upper end to project perpendicularly through and exactly fit between the

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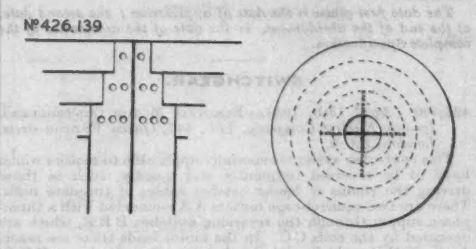

opening in each disc or plate, the upper ends of the partitions resting flush against the underside of the uppermost plate or disc, by which partitions that plate is held and supported. By reason of these midfeathers, a wind will cause a downflow of air in those two quadrants or sections which are on the windward side of the fitting, while extraction takes place from the two quadrants or sections on the leeward side, thus simultaneously passing fresh air into and extracting foul air from a room or building.—*March 28th*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

To-day.

Inst. of Sanitary Engineers.—Caxton Hall, Westminster, S.W.1. "From the View Point of a Rural Medical Officer of Health," Dr. J. J. Paterson. 6 p.m.

Physical Soc.—At Imperial College of Science and Technology, S. Kensington, S.W.7. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.; meeting, 4.45 for 5 p.m.

Royal Inst. of Great Britain.—Burlington House, W.1. Conversazione. 9 p.m.

To-day and Saturday, May 18th.

British Glass Convention, Folkestone.—Headquarters, Grand Hotel, Folkestone. Full particulars from the Hon. Secretary, Glass Convention Offices, Norwich House, 13, Southampton-street, High Holborn, W.C.1.

Monday to Friday, May 20th to 31st.

British Industries Fair: Engineering and Hardware Sections.—Castle Bromwich, Birmingham. Daily except Sunday.

Tuesday, May, 21st.

Inst. of Fuel.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. "The History and Construction of the Iraq Pipe Line," Sir John Cadman. 6 p.m.

Inst. of Mechanical Engineers.—Visit to British Industries Fair, Castle Bromwich.

Manchester Assoc. of Engineers.—Visit to the works of the Lancashire Steel Corporation, Ltd., Irlam. 2.30 p.m.

Wednesday, May 22nd.

Inst. of Electrical Engineers: South Midland Centre.—Visit to Droitwich Broadcasting Station. 3 p.m.

Friday, May 24th.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Discourse by Mr. S. C. Roberts. 9 p.m.

Saturday, May 25th.

Inst. of Electrical Engineers: Wireless Section.—Messrs. Cable and Wireless, Ltd., have invited the members to visit (i) The Central Station, Electra House, Moorgate, E.C.2; (ii) the Wireless Station at Ongar, luncheon at Theobalds Park Hotel, Waltham Cross; (iii) Wireless Station at Brentwood. 9.30 a.m.

Physical Soc.—Visit to Royal Holloway College, Englefield Green. Leave Charing Cross Underground Station, 1.30 p.m

Tuesday, May 28th, to Friday, May 31st.

Inst. of Mechanical Engineers.—Summer meeting at Bath.

Thursday, May 30th.

Royal Aeronautical Soc.—In the Science Museum, South Kensington, S.W.7. Wilbur Wright Memorial Lecture and Conversazione. The Memorial Lecture will be read by Mr. D. W. Douglas. 9 p.m. to 12 midnight.

Thursday, May 30th, to Saturday, June 1st.

Inst. of Automobile Engineers.—Joint Summer Meeting with the Société des Ingenieurs de l'Automobile. Visit to Midlands and Oxford. For programme, see page 372, April 5th, 1935.

Friday, May 31st.

Railway Club.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. "How the Railways Fight the Snow," Mr. H. A. Vallance. 7.30 p.m.

Tuesday, June 4th, to Friday, June 7th.

Inst. of Gas Engineers.—At Inst. of Civil Engineers, Great George-street, S.W.1. Seventy-second Annual General Meeting. Presidential Address by Mr. C. V. Bennett. Paper, "National Policies Governing the Testing of Gas Appliances," Mr. Stephen Lacey and Mr. C. A. Masterman, 10 a.m.; President's luncheon at Savoy Hotel, 12.45 p.m. Afternoon session: Papers, "Problems and Answers in the Reconstruction of Manufacturing and Distributive Plant, Nottingham," Mr. G. Dixon, and "The Gas Account," Mr. W. B. McLusky, 3 p.m.; Park-lane Hotel, W.1, reception and dance, 9 p.m. Wednesday: "Development of Gas Sales: Policy and Performance," Mr. S. B. Chandler; 10 a.m., general meeting of Benevolent Fund; 11 a.m., lecture, "The Tactical Use of Carburetted Water Gas as a Coal Gas Auxiliary," Dr. A. G. Glasgow, 11.15 a.m.; visit to Rochester Gasworks, 12.50 p.m. Thursday: Papers, "Waste Heat Recovery from Retort Settings," Major W. Gregson, "The Preparation, Marketing, and Utilisation of Coke," Mr. W. L. Boon, 10 a.m.; afternoon: Visits. Friday: Tour in Kent, leave Victoria, 9.20 a.m.

Saturday, June 22nd.

Inst. of Automobile Engineers: Graduates' Section.—Summer Rally at Burford, Oxon. The President, Mr. L. H. Pomeroy, and Mrs. Pomeroy will hold a reception at the Cotswold Gateway Hotel, Burford, at 3.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Brown Brothers, Ltd., have built new warehouses at 93–97, Victoria-street, Bristol, which will be open for business on Monday, May 20th.

The Selson Machine Tool Company, Ltd., has appointed Major F. L. Watson, M. Inst. C.E., M.I. Mech. E., of Post Office House, Leeds, 1, to be its representative for the sale of machine tools in Yorkshire.

G. D. Peters and Co., Ltd., of Slough, announce that Mr. Robert Lowe has joined their staff in connection with their activities in the production of special alloy irons for heat, wear, acid, and corrosion resistance, and also in connection with the production of non-ferrous castings for all purposes.

G. A. Harvey and Co. (London), Ltd., announce that Mr. W. F. Hardstone has been elected a director of the company. Mr. Hardstone has been with Messrs. Harvey since 1893, and for a great number of years has been associated with the metal perforation department, holding the position of general manager since 1931.

The Universal Dryers Company, Ltd., Barnsley, informs us that the sole manufacturing and selling licence of the Universal Dryer, hitherto held by the Brightside Foundry and Engineering Company, Ltd., of Sheffield, has been terminated as from May 6th, and that Mr. R. V. Farnham, the patentee and designer of the Universal coal dryer is now the engineer and manager of the Universal Dryers Company, Ltd.

Chance Brothers and Co., Ltd., of the Glasgow Glass Works, Firhill, Glasgow, N.W., inform us that the works plant is being reconstructed for the manufacture of various window glasses. The new process of manufacture now being installed is of the latest type designed for the continuous production of roofing glass for factories and ornamental glass for buildings. This improved plant and the central position of the works will enable the firm to supply glass to Scotland, the North of England, and Ireland, and to ship from the Clyde to all parts of the world.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

British Timken, Ltd., of Aston, Birmingham, has received an order for eighty-eight complete roller-bearing axle-boxes for fitting to locomotives and coaches of the Entre Rios Railways, Argentine.

Simon-Carves, Ltd., of Stockport, has received from John Walker and Co. (Sugar Refiners), Ltd., Greenock, an order for a new boiler plant comprising three 30,000 lb. to 45,000 lb. per hour boilers fired by chain grate stokers. The boilers will work at 315 lb. per square inch pressure. The combustion chambers will be water cooled throughout. The order includes superheaters, economisers, stokers, fans, motors, and starters, chimneys, grit catchers, soot blowers, &c.

The same firm has received from the Tata Iron and Steel Company, Ltd., an order for a complete by-product coking plant to be built at the Jamshedpur steel works, about 150 miles from Calcutta. The value of the contract is over half a million pounds sterling. The order comprises a battery of fifty-four "Underjet" twin-flue, compound coke ovens, arranged for firing by either rich or blast-furnace gas, or both, and having a normal capacity of 1300 tons of coal per day, with a maximum capacity of 1560 tons per day. The ovens will be arranged so that they may be extended later to give a daily throughput of 4800 tons of coal. The by-product plant will comprise primary condensing plant, electrostatic tar precipitation, high-speed, large-capacity gas exhausters, and final cooling and naphthalene-extraction plant. Gas-boosting plant to deliver the whole of the coal gas made in the ovens to the steel works for furnace firing, &c., will be included. The machinery includes electrically operated ram, coke-charging car, two coke guides, coke car and locomotive, and an automatic weighbridge for coal. The coke-screening plant will be built to screen the coke from the ovens into blast-furnace and domestic sizes, the blast-furnace coke being delivered either direct to the furnaces or into wagons. The contract also includes a 3500-ton steel coal service bunker, and all foundation work.

LAUNCHES AND TRIAL TRIPS.

Craster, single-screw steamship; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of the Tyne-Tees Steam Shipping Company; dimensions, 215ft. by 32ft.; to carry passengers and cago. Engines, triple-expansion; constructed by the builders. Launch, May 2nd.

Rotula, single-screw motor tanker; built by the Netherland Shipbuilding Company, to the order of the Royal Shell Company, The Hague; dimensions, 460ft. by 59ft. by 34ft.; to carry oil in bulk. Oil engines, eight cylinders, of 650 mm. by 1400 mm.; constructed by Messrs. Werkspoor, of Amsterdam; trial trip, May 2nd.

Nymboida Hydro-electric Undertaking.—We regret that owing to a slip of the pen, "New Zealand" was written instead of "New South Wales" in the title of the article on the Nymboida Hydro-electric Undertaking on page 487 of our issue of May 10th. We trust that the references in the article made the error obvious to our readers.

Plastic Metal.—For some time past various forms of so-called "plastic metal" have been obtainable generally consisting of a metal powder in a cellulose or other liquid base. Like the material known as plastic wood these plastic metals suffer from the disadvantage that even in an airtight tube they change from a paste into a solid form in a comparatively short time. From the Rawlplug Company, Ltd., Cromwell-road, London S.W.7 we have received a sample of a new product, a plastic metal which is in the form of a fine powder and which when it is to be used is mixed with water to the consistency of a stiff putty. So mixed the material sets quickly to a hard metallic form resembling cast iron in appearance. The dry powder is stated to keep indefinitely without deterioration. The material can be used for filling cracks in any kind of metal, for stopping leaks and for a very large number of domestic and workshop purposes. It has approximately the same coefficient of thermal expansion as iron and therefore does not show any tendency to loosen and fall out of place at elevated temperatures. It is, we find, feebly, if at all, electrically conductive.